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DAY LOAD IN CENTRAL STATIONS.

The paper recently read by Mr. H. Ward Leonard before the American Institute of Electrical Engineers, and abstracted in our last issue, brings out very strongly the great importance of the load factor in central station, and offers some very striking comparisons as to its effect. It is pointed out that the very small load factor in European stations is what has rendered the employment of the storage battery so profitable there, and while the conclusion of Mr. Leonard that in our large cities the load factor is much larger than abroad is correct, yet it should be remembered that not many of our 2,400 central stations come in this category, the conditions in all but a very few being such as to promise a large gain in economy from the use of storage batteries. That central stations can make a rate of 4 cents per kilowatt for a day load with a resulting profit, as asserted by Mr. Leonard, seems to us problematical under present conditions as to investment and cost of operation. It is already the custom in this country to make a much smaller charge for day motor loads, but the lowest price charged that we know of is more than 10 cents per kilowatt hour, and it is a long distance from this to 4 cents. Should, however, it be possible to furnish power at the rate named, there would seem to be little difficulty in attaining the necessary load, as the price would be equivalent to less than $100 per yearly horse power, which is cheaper than steam power can be generated in a city in quantities of less than 15 or 20 horse power, exclusive of the value of the space occupied by the plant. It may be added that such a case would represent the anomaly of a quarter or less of the output paying almost the entire fixed charges of the remainder, or, in other words, making up for the loss at which the latter is sold.

ACETYLENE GAS.

The newspapers have taken up the subject of acetylene gas, and, as was to be expected, are making it a subject of sensationalism, the public being informed that it can be produced so cheaply that ordinary gas and electricity will probably be displaced. Much stress is laid upon the advantages possessed by reason of the portability of the carbide from which it is formed, and it is stated that houses can consequently be supplied with the gas in cylinders, and that the carbide will be sold in sticks for use in lamps. It is well to understand, however, that the claim for cheapness has not yet by any means been satisfactorily demonstrated. The price of $12 per ton for the carbide, which is that usually quoted, rests upon a cost of electrical energy of only $5 per yearly horse power, and in estimating the price of the gas to the consumer, no proper allowance is made for the cost of distribution and fixed charges. If we were to estimate, for example, the cost of the electric light on the same basis, a figure would be arrived at that would place gas at $1 per thousand totally out of competition. The price named for electrical energy at Niagara is $18 per yearly horse power at the generator terminals, which would probably bring the cost not far from $25 at a reducing furnace, this figure taking account of losses in transmission and transformation, charges on investment, etc. On the basis of $25 per annual horse power for electrical energy, a writer in the *Journal* of the Franklin Institute estimates that the cost of acetylene gas would be $3.70 per thousand, and assuming that its illuminating power is ten times greater than that of ordinary gas, as claimed, this would be equivalent to 37 cents per thousand as compared with the latter. This, however, would be merely

the cost of manufacture, which is quite different from the final cost as delivered to the consumer. We are informed that in Philadelphia the city purchases gas from private works for 35 cents per thousand, and therefore the new gas would seem to be more expensive than ordinary gas even on the basis of an estimate which apparently neglects several factors in the total cost of production.

ELECTRICITY DIRECT FROM FUEL.

We print elsewhere the reply of Dr. Borchers to criticisms on his gas battery, with rejoinders by two of his former critics. From these latest contributions to the subject it will be seen that the matter of generating electricity direct from fuel with the absence of heat is yet far from being demonstrated a practical possibility, and we trust that the further results which Dr. Borchers has promised to communicate will have a more certain basis. As pointed out by the London *Electrician* and by Mr. C. J. Reed, it is idle in a matter like the one at issue, where there is a possibility of the existence of many complicated actions, to rely upon qualitative observations or to neglect investigation of any of the factors that may possibly affect the result. Nor will a demonstration be sufficient in which any of the necessary points depend for their proof merely upon the indications of chemical equations, for Mr. Barnes shows how unsafe this method has been in the present instance. While such equations are valuable for representing known relations, and may give useful indications as to possible reactions, the discussion of the Borchers battery shows what was already known, that they cannot be applied with any degree of certainty when entering a new field of investigation. We commend to our readers the statement by Mr. Reed of the problem implied in the production of electricity direct from fuel, as we believe it to be not generally understood. It consists in the conversion of the energy of fuel into electrical energy without heat and without the destruction of chemical reagents or the formation of waste products. This, it will be recognized, is something entirely different from deriving electrical energy direct from heat, though the two cases are sometimes confused. In the former case the theoretical efficiency of conversion may be 100 per cent., but in the latter it is limited in the same manner as in the steam engine, and in fact the process would be classed under that of heat engines; that is to say, the theoretical efficiency of conversion would be the ratio of the difference of temperature involved in the process to the extreme absolute temperature. Under this latter head, for instance, come regenerative batteries like the Case battery, thermo-magnetic generators like that of Edison, and thermo electric piles.

THE DEMAND FOR ELECTRICAL ENGINEERS.

A writer in another column takes a somewhat pessimistic view of the profession of electrical engineering, which at least serves to show that it bears a likeness to all other professions in admitting of argument to prove that it is a field to be avoided. The overcrowding of professions has, we presume, been a theme for lamentation by members thereof ever since professions have existed. From the days of Athens to the present the overcrowding of the legal profession has disturbed its members, and about commencement time we yearly read the darkest forebodings as to the prospects of newly graduated doctors; yet law and medicine have always contained fair opportunities for the young man. While we agree that the popular fallacy as to the future of electricity has caused an abnormal flux of young men into the profession of electrical engineering, and that entirely too much stress has been placed upon the teaching of designing, yet we cannot believe that the present opportunities in the profession are as narrow as asserted. Moreover, the proportion of central stations and electric railways that will offer profitable employment to educated engineers will grow yearly as it becomes recognized that the present hap-hazard manner in which the majority of these are run does not pay—and there are over 2,400 of the former and 600 of the latter in this country. If any serious mistake has been made with respect to educating electrical engineers it has been rather as to the manner of education, which we think has been, as a rule, too narrow, thereby circumscribing the opportunities of graduates. A graduate of a technical course, which aims primarily to train the mind and teach broad principles, practical instruction being subordinated to these objects, may not so readily find minor positions immediately upon the completion of his studies, but the future is more certain for him than it is to one whose training has been industrial rather than educational. The more special the training of the latter, the more limited are his opportunities in the future, not only on account of the narrower range of employment available, but also from the lack of versatility incident to a system of education in which the mind is either not developed at all in its higher faculties or merely trained in one direction. The survey which Mr. Ford takes of the electrical field is an extremely limited one, for it does not include among other positions those in the executive department or business branches. While it may be true that most technical graduates at the present time would be handicapped in their aspirations for these positions by graduates of high schools or of college classical courses, we see no reason why a technical education should have this tendency. If the principle were recognized that breadth of view and flexibility of intellect are not incompatible with technical skill, the opportunities of graduates would be vastly extended, and with no sacrifice except in detail knowledge, which can be much better acquired in actual work than in college kindergartens.

London Electric Lighting Companies.

The London *Electrician* gives a flattering account of the leading low tension electric lighting companies in London. Taking the companies in the order of their capital expenditures, it finds the Westminster Electric Supply Corporation at the head of the list, with a capital expenditure of some £411,000 and an output of some 2,173,000 units, this well-managed concern actually decreasing its xpenses in face of a 27 per cent. increase in its output. The St. James and Pall Mall Electric Light Company has now a capital expenditure of some £227,000 and an output of 1,570,000 units. The legal expenses of this company gave rise to some grumbling at the annual general meeting, and it is not perhaps altogether cheering to learn that more "nuisance" litigation is pending; such misfortunes can, however, be accepted with some equanimity in face of a 6½ per cent. dividend, and may be considered as disagreeable incidents in a not altogether unpleasant campaign. The Charing Cross and Strand Electricity Supply Corporation comes next, with a capital expenditure of some £212,000 and an estimated output of some 950,000 units. The Kensington & Knightsbridge Electric Lighting Company, which has not, by the way, overcome its early coyness in the matter of presenting accounts to the shareholders in Board of Trade form, follows next with a capital expenditure of something like £187,000 and an output of about 978,000 units. This concern has succeeded in augmenting its income by 33 per cent., with an increased expenditure of only 20 per cent. Lastly, we come to the Chelsea Electricity Supply Company, with its capital expenditure of £120,000 and its output of 469,000 units, and which has managed to bring down its sheer cost of production by one-third of a penny. All these companies, therefore, tell the same tale of increased output and decrease in the ratio of working expenses to revenue. All of them are paying satisfactory dividends, the same as last year in some cases, more than last year in others.

A Brilliant Discovery.

An electrical contemporary informs its readers that according to the recent Bate Refrigerating decision, the Edison lamp patent expired on May 10, 1894, and, therefore, "This decision will also have the effect of throwing out of court those cases for infringement of the lamp patent brought by the General Electric Company since the date of May 10, 1894, and doubtless affect other litigation of the same character!"

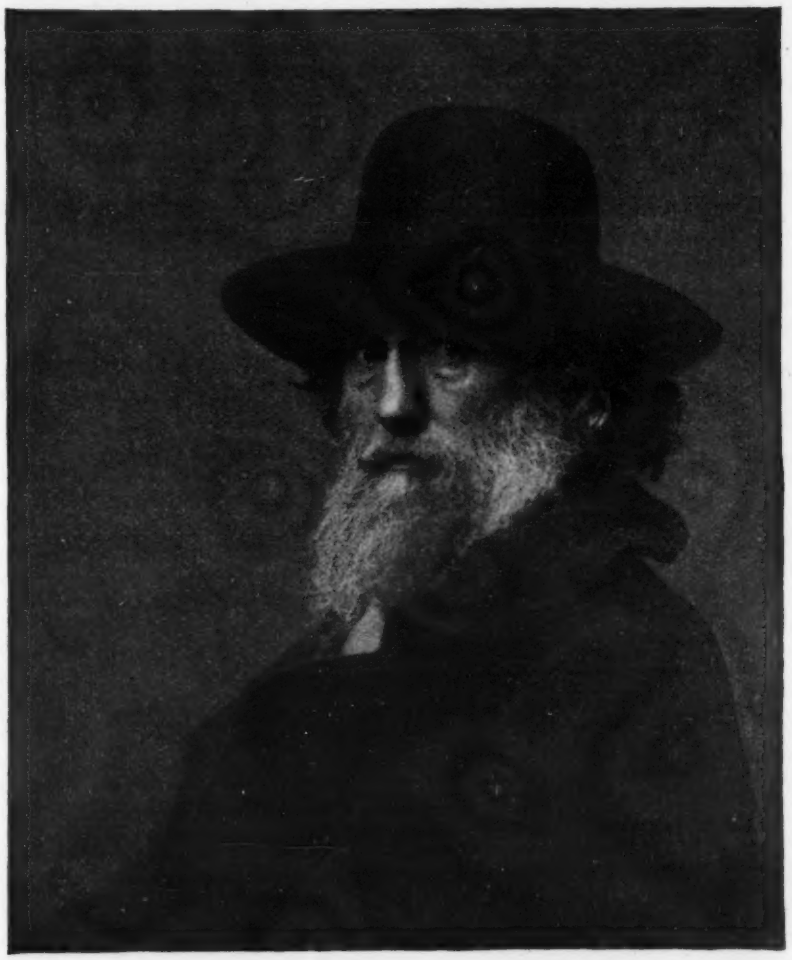
Rudolf Eickemeyer.

BY CHAS. PROTEUS STEINMETZ.

Since I had the honor to be very well acquainted with the late Mr. Rudolf Eickemeyer, who died in Washington, Jan. 28, on his way to the South, and was associated with him for many years, a few notes on his long and useful life may be of interest.

Mr. Eickemeyer was the most intelligent of all the men I ever met. He was well versed not only in his particular lines of work, but in all branches of exact science and art, and was able to discuss intelligently problems of electric and mechanical engineering, as well as political economy or literature, music and art, biological or physiological problems, and had also done original work in many directions.

Mr. Rudolf Eickemeyer was born Oct. 18, 1831, in Bavaria, where his father was governmental forestry officer. He attended the Realschule of Kaiserslautern and afterward the Polytechnic Institute at Darmstadt. At the outbreak of the revolution of 1848 he, with his friend, and later partner, George Osterheld, joined the insurgents, as all the boys of his generation did. Thus he participated in the campaign in South Germany and was present at the siege of the Bavarian fortresses of Landau and Kaiserslautern. Of this period of his life he often told the most interesting and amusing incidents in later years. The arrival of the Prussian army scattered the heretofore victorious rebels, and although a large majority of them were amnestied, it very soon became evident to them that Germany of that time, as later and before, had no use for talents which did not renounce their political opinions in blind obedience to their rulers. Thus sooner or later most of the participants in the rebellion came to America, and in 1850 Rudolf Eickemeyer, with his friend, George Osterheld, left Germany and embarked for this country, arriving in New York in November.



RUDOLF EICKEMEYER.

However, America at that time was not the industrial country that it is now, but was still very largely dependent in this respect upon Europe, especially England, and, therefore, offered small opportunities to technically educated men. Mr. Eickemeyer worked on the building of the Erie Railway, and later found employment in the Buffalo Steam Engine Works, but a strike there caused him to leave and return to New York, and in 1854 he established a small repair shop in Yonkers.

Since the hat manufacture was Yonkers' foremost industry at that time, he frequently had occasion to repair hat machinery, and thus came to see the defects of the machinery. He was thus led to make improvements, and invented new and better machinery for which he took out patents. In this way a new industry, the building of hat machinery, originated in Yonkers, and for a long time the Eickemeyer Company practically monopolized the hat machine industry, and is still the leading concern, its export trade, especially with England, being very large. Besides hat machinery different agricultural machines, including an improved mowing machine, were invented and manufactured by Mr. Eickemeyer, and companies licensed by him. Upon the outbreak of the war of secession Mr. Eickemeyer turned his works into an arms factory and manufactured revolvers in large quantities.

As soon as Mr. Eickemeyer had settled down in Yonkers he renewed his interest in the progress of scientific thought, and closely followed all publications and investigations in the sundry branches of exact science. Thus, when in the seventies the science of electricity came in the foreground, he did considerable experimental work, took out patents on telephones, etc. He was, however, entirely original in his work, and never followed in the beaten track of other investigators, but first found for himself by reasoning or experiment the solution of the problem which interested him, and then compared it with what others had done.

His first experiments in electrical machinery were on unipolar machines. They brought no direct return, but offered a splendid occasion to fully grasp the problems of the electromagnetic circuit, very little understood at that time. The first commercial application he made in the invention of the iron-clad dynamo now generally known from its use as a motor in all first-class electric elevators.

Since 1884 the old factory had been largely turned into an electric laboratory and work shop, and numerous electrical machines built, such as train-lighting dynamos—where the iron-clad form offered special protection against the carbon and iron dust always present with running railway trains, railway motors, elevator motors, lighting and railway generators, etc. The first two railway motors were operated in 1888, on a branch of the Steinway road in Long Island City. In 1889 the first direct coupled railway motor was finished. Later the electric railways of Lynchburg, Toledo, Yonkers and the Steinway road in Long Island City were fitted out with Eickemeyer motors directly coupled to both axles by parallel rods. However, the limited facilities of the old factory and the rapidly increasing demand for elevator motors made it impossible to follow the demand of any other kind of machinery sufficiently to gain an appropriate share of the market. Thus transactions with the General Electric Company led, in 1892, to a consolidation of the interests. A large factory exclusively for the production of elevator motors had in the meantime been built by Eickemeyer and Otis Brothers, the well-known elevator manufacturers in Yonkers, and put in operation, and the demand for hat machinery, in which the orders were many years behind, induced Mr. Eickemeyer in the last years to use the old factory again mostly for the production of this class of work, without, however, entirely giving up experimental electrical work.

A number of scientific investigations on hysteresis, high potential phenomena, etc., have been made in the Eickemeyer laboratory with Mr. Eickemeyer's personal co-operation, and are recorded in the Transactions of the American Institute of Electrical Engineers. Mr. Eickemeyer was probably the first to understand the importance of testing the iron used in electrical machinery for permeability as well as hysteresis, and special instruments were invented by him for this purpose. Considerable experimental work on alternating current machinery, especially with single-phase motors, was carried out in the Eickemeyer laboratory, but had not left the experimental stage when the consolidation with the General Electric Company's interests was made; the results, however, were utilized in connection with work done contemporaneously at Lynn, and since that time have led to what is now the modern alternating current practice.

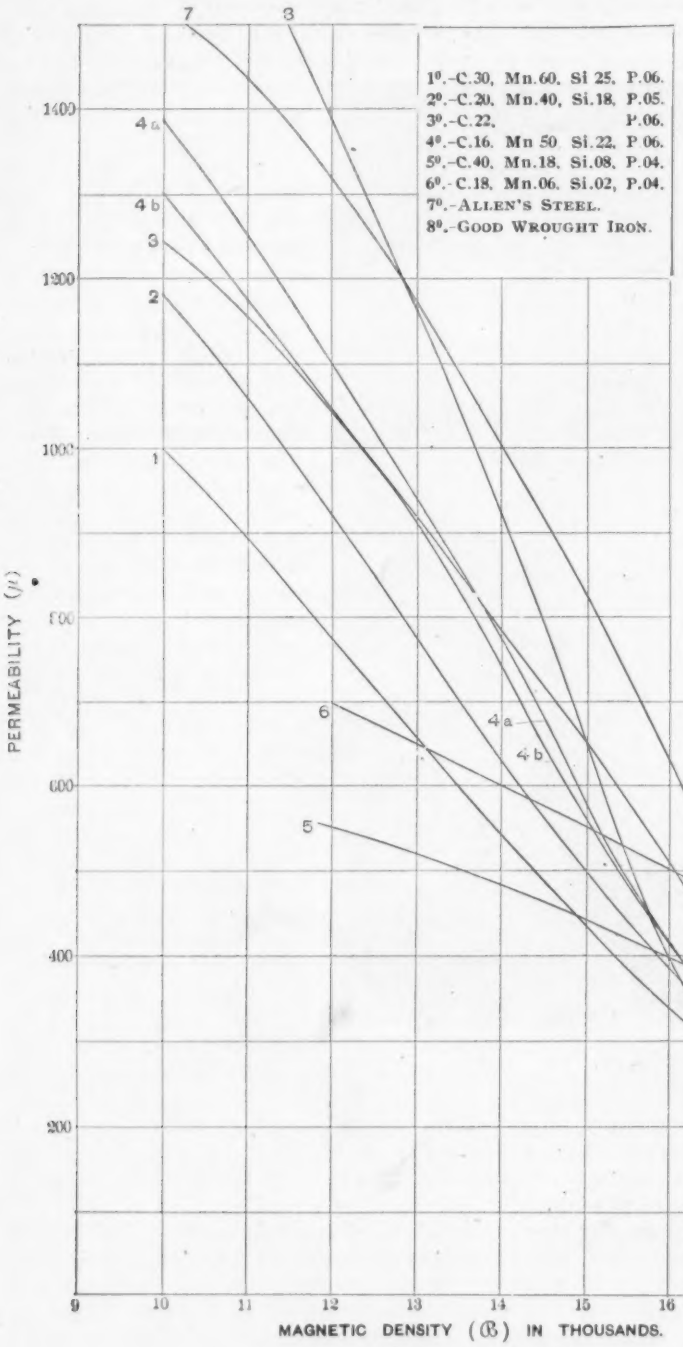
Several years ago Mr. Eickemeyer suffered from a severe attack of the grippe and never completely recovered, being obliged to spend the winter in the South. As the result of his sojourn in the South two years ago he published "Letters from the Southwest," as a manuscript for his friends, sketching in the most interesting and entertaining manner the habits and customs of the people of the Southwest States.

It was while on the way to the South that business delayed Mr. Eickemeyer in Washington until it was too late. America thereby lost one of its foremost inventors and engineers.

The Permeability of Mild Steel.

BY DUGALD C. JACKSON.

I note in your issue of Feb. 2 that Mr. Wiener includes in his very complete series of articles on the design of dynamos some data relating to steel castings. I wish to call your attention to certain facts in relation to steel castings which apparently Mr. Wiener does not bring out. On page 54 of my "Text Book on the Construction of Dynamos" will be found the following statement in regard to the effect of impurities upon the magnetic quality of mild steels.



Permeability Curves.

"1. The permeability depends inversely upon the amount of carbon present.

"2. The permeability depends inversely upon the amount of manganese present when it much exceeds .15 per cent."

These statements in regard to the effect of carbon and manganese and those in regard to other impurities which follow on the page were enunciated after a careful study had been made of various test pieces tested by myself, and of the reports on magnetic testing made by Hopkinson, Ewing, Henrard and others. Since early in 1893, when the paragraphs which I have just quoted were written, I have made various additional tests of mild steels, and have added to my collection of data the results of many tests made by others.

Taking the results as they come, there seems to be quite conclusive proof that manganese in as large a percentage as .60 per cent. has a marked injurious effect upon the magnetic quality of steel castings. The highest magnetic tests of mild steel castings of which I have any record are given by Henrard in "La Lumière Electrique," Vol. 33, and by Ewing in a circular issued by Edgar Allen & Co., steel founders of Sheffield, England. In the latter sample especially the manganese was exceedingly low, and while that is only one factor in the high grade of this particular steel, I have little doubt that it is quite a marked factor.

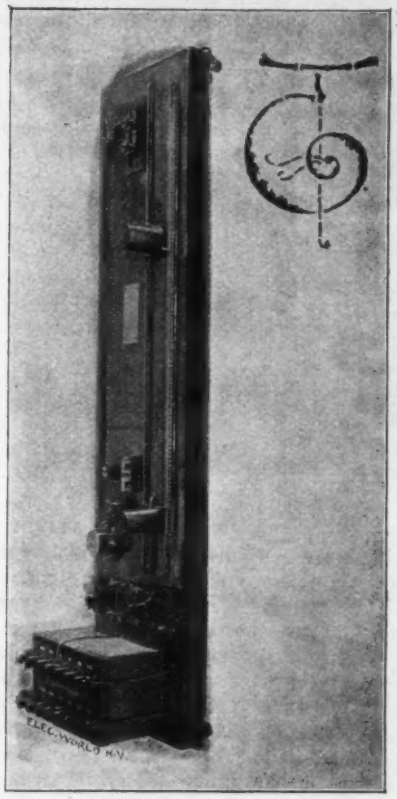
Attached herewith is a series of half a dozen curves showing the permeability of steels made by different manufacturers. Alongside of the curves is a table showing the composition of the samples. The difference between the steels carrying .40 per cent. or more of manganese, and the three samples carrying a very small amount of manganese is quite marked. Any of the steels whose curves are shown here, when made into solid castings of uniform quality and of reasonable price, make much the best material for ordinary forms of dynamo magnets when it is desirable to use large magnetic densities. It is to be regretted that the steel founders were not drawn into the discussion regarding materials for dynamo frames which lately took place at a meeting of the American Institute of Electrical Engineers.

A Two-Phased Alternating Plant.

In the discussion, at the Cleveland Convention, of Dr. Bell's paper on the monocyclic system, Mr. W. R. Gardener, of Pittsfield, Mass., said he was much interested in the question of multiphase apparatus, and while he did not pretend to know anything about polyphase or multiphase systems, or of teasers, he did know that he had something in his station that gave perfect satisfaction, and fulfilled his requirements as a central station man—a two-phase machine which had been in operation for over a year and a half. The first work required of the two-phase machine was to supply a 15-hp motor a mile and a half from the station over an existing circuit. An extra wire was run, and from that circuit there were also furnished incandescent lights to stores and dwellings. Later on a fire occurred in a mill, destroying its engine, and two motors of 20-hp each were installed there upon this circuit, giving perfect satisfaction. The business increased so as to necessitate putting in a larger machine, and to-day power, incandescent and arc lights are furnished from this one machine. The station has five alternating current machines, of from 750 to 1,500 lights capacity, as good to-day as when they were bought, but two-phase machines will be substituted for them. The item of repairs on ordinary apparatus is enormous, while with these two-phase machines, including the transformers and motors, not one cent has been spent. The five machines referred to will be displaced by one two-phase machine, and instead of dynamo attendants bobbing from one end of the switchboard to the other and reading five ammeters and voltmeters, they will then have to read but one. No difficulty has been experienced on the two-phase lines in operating motors and lamps simultaneously on the same circuit, even with one side carrying a considerably larger load than the other.

The Glasgow and West of Scotland Technical College.

BY ANDREW PINKERTON.



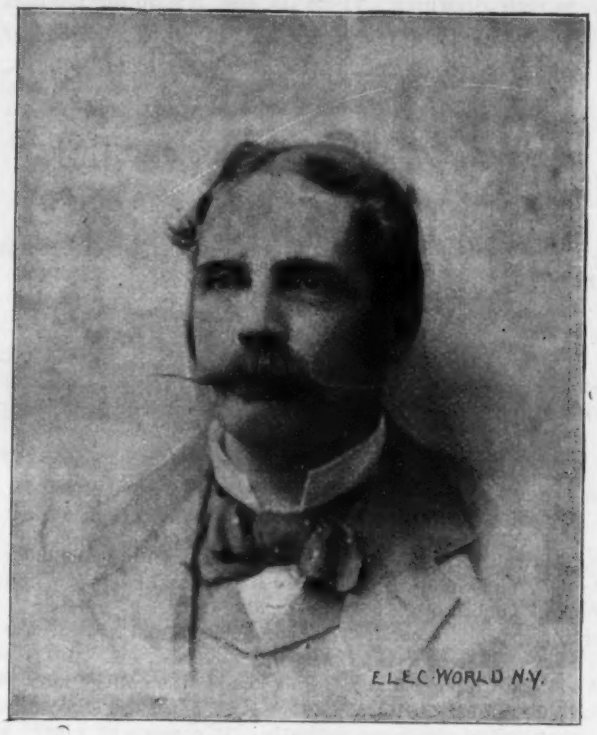
THIS famous Technical College was created in 1886 by the amalgamation of three previously rival institutions, Anderson College, College of Science and Arts, and Allan Glen Institution, and by the inclusion of the Atkinson Institution. Anderson College, the first technical college, started with the appointment of Dr. Garnett to the chair of natural philosophy and chemistry in 1796. Anderson College also embraced a medical school, beginning with the appointment of Dr. Burns to the chair of surgery and anatomy in 1800. On the creation of the Technical College, the medical school was organized as a separate institution.

In 1823 the members of the mechanics' class of Anderson College started a separate institution, the Mechanics' Institution, with Dr. Birkbeck, a previous Anderson College professor, as honorary patron. Three days later the formation of the London Mechanics' Institution was decided on, with Dr. Birkbeck as president.*

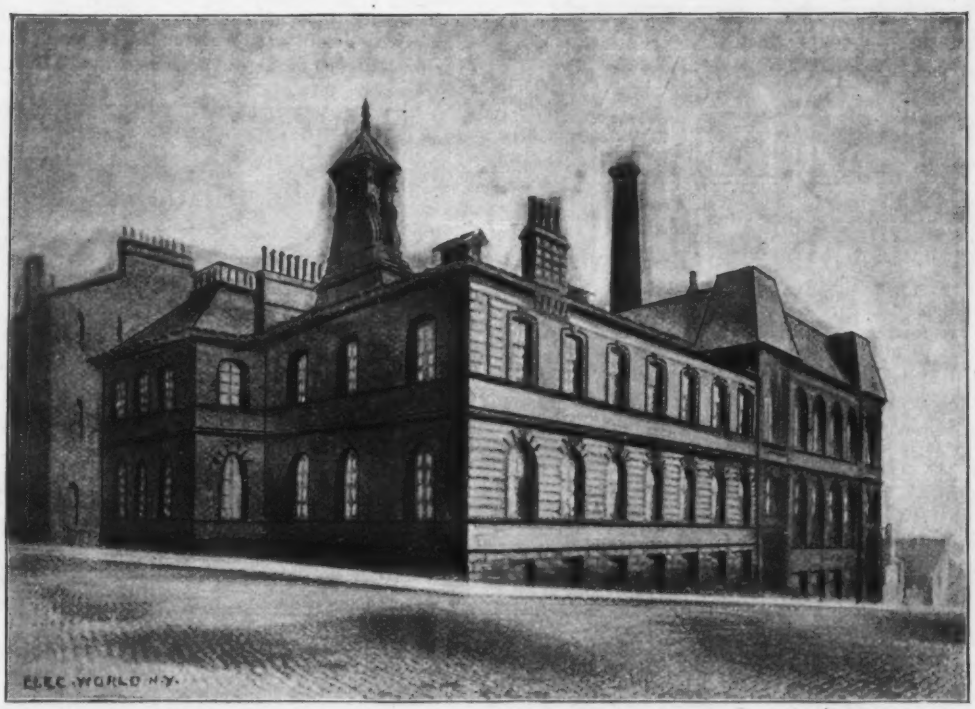
The Atkinson Institution never reached practical work, the funds being left to grow, and are now used to provide bursaries in the Technical College.

The Allan Glen Institution started in 1853 to provide free elementary education. On the school boards dealing with this question, the trustees obtained enlarged powers, and in 1878 the institution was reopened as a secondary and technical school, with well equipped laboratory, workshop, and class rooms, and soon became the best example of a technical school in Great Britain.

The Technical College, as now constituted, is under the direction of a very representative Board of Governors, 30 in number, and the work is carried on by a staff of 10 professors, 19 lecturers, 5 extension lecturers, 12 teachers in the industrial art department, and 17 chief assistants. Besides these there is the separate staff in Allan Glen Institution, under headmaster John G. Kerr, M.A. Pupils enter Allan Glen Institution at about 10 years of age, after undergoing an entrance examination. As they go forward in the classes they get, besides a sound general education, instruction in chemistry, electricity, mathematics, mechanics and other engineering subjects, accompanied by practical work in the chemical and physical laboratories and workshops. These are well equipped, the workshop containing 12 turning lathes, a drilling machine, forge, etc., and having provision for moulding and casting from the patterns made. Pupils in the highest class usually specialize for chemistry, engineering or art. There are numerous bursaries and scholarships to assist pupils in the institution, and three bursaries open to pupils going on to a university, or day technical college, or school. The Technical College proper may be divided into day and evening courses. Both courses have departments in mechanical engineering, naval architecture, electrical engineering, architecture, metallurgy, chemistry, agriculture, mathematics and physics. The day course has also departments in civil engineering, chemical engineering and mining engineering, while the evening course has departments in building construction, mining, chemical industries, textile industries, art industries and commerce. The diploma of the college is granted to day students in the various departments who complete the course, usually lasting three years, and pass the requisite examinations. The certificate of the college is granted to evening students who complete the course, usually lasting four years, and pass the prescribed examinations. In electrical engineering the course of study embraces higher mathematics, higher physics, higher dynamics, natural philosophy, mechanical engineering, chemistry, and electricity, accompanied with a great amount of practical training in the workshops and laboratories. The student for the diploma has to pass an entrance examination in general education, and a science or diploma examination at the end of each year. The assessor in the final examination is Lord



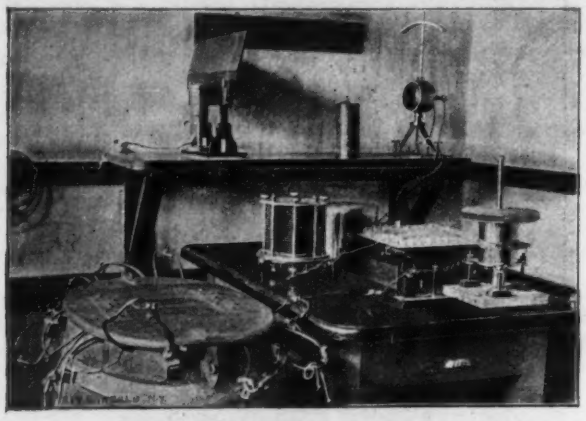
PROF. ANDREW JAMIESON.



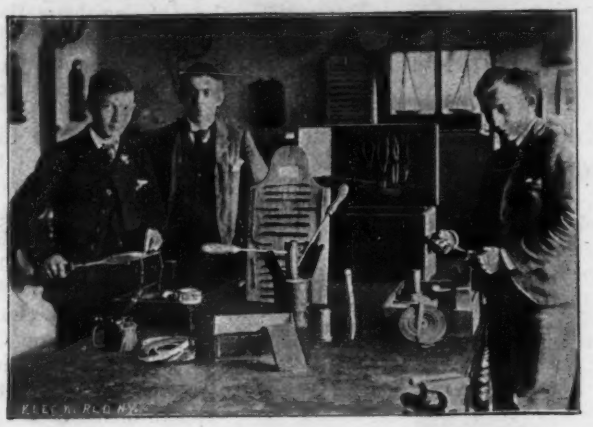
ALLAN GLEN INSTITUTION.

* The Glasgow Mechanics' Institution changed its name in 1881 to The College of Science and Arts, and remained so till the creation of the Technical College.

Kelvin (Sir William Thomson). The college is amply fitted for practical and laboratory work. There are wood-working and metal working shops well supplied with machine tools, and all work is done to scale drawings. There is also a shop for plumber work practice. The physical laboratory has an engine, dynamos, storage



CABLE TESTING APPARATUS.



JOINTING.

cells, optical bench, polariscopes, etc., and accommodates 30 students. The chemical laboratory for general chemistry consists of a general laboratory, advanced laboratory, gasometric analysis laboratory, special laboratory for combustion analysis, furnace work, etc., and a laboratory for spectrum analysis, etc. It is situated in Anderson College, and is what made the college most famous.

The "Technical Chemical Laboratory" is for the study of chemistry as applied in commerce specially. It consists of a large separate building, containing general and smaller laboratories, gas analysis and balance rooms, museum and lecture room, and special provision is made for private work by inventors, etc., with or without the professor's assistance. Students are expected and encouraged to

COLLEGE OF SCIENCE AND ARTS.

make original research. Courses of lectures are delivered on such subjects as destructive distillation, dyeing processes, etc. It is also equipped with a special laboratory for photography. The metallurgical laboratory is fitted with assaying laboratory, furnace room with wind furnaces, coke and gas muffles, etc. There is a general drawing office, and a prime movers' drawing office and laboratory. The latter is fitted for steam and gas engine experimenting and testing, and with apparatus for steam generation experiments, etc. In the drawing office senior students take up some special form of

motor, and receive special instruction in the practical design and calculations regarding it.

The electrical engineering laboratory is the one of most interest to readers, and it is the best equipped in the college. It consists of four rooms, and has a steam engine specially designed by the professor for accumulator charging and experimental work. There are four dynamos, accumulators, ammeters, voltmeters, galvanometers of all kinds, transformers, Wheatstone bridges and testing sets, and provision for making all kinds of tests and experiments. Some of the apparatus merits special attention, having been used by Lord Kelvin and Prof. Fleeming Jenkin on Atlantic, Brazilian and other cable expeditions. One special piece of apparatus is a splendid low resistance bridge (shown in initial cut), presented to the college last year by Messrs. Siemens Bros. & Co., London, in recognition of good work done by the students in testing their new type "Obach" dry cell. A great number of the instruments used are made by the students in the laboratory workshop. The laboratory owes much of its success to its untiring head, Prof. Andrew Jamieson, who is widely known in the electrical world. He has spared no exertion to secure its success, to increase its equipment and to promote to the utmost the interests of his students, who are now to be found in all parts of the world.

What is called the extension scheme consists of instruction given outside the college by teachers in connection with it. The subjects taken up are plumbing, agriculture and fisheries. In connection with agriculture lectures are given under the auspices of the various local boards on agriculture and chemistry, as well as practical instruction in butter making and experiments carried on in fertilizing, crop raising, etc.

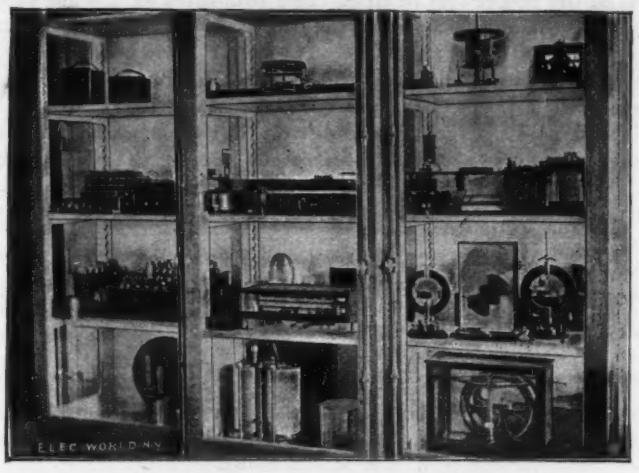
ANDERSON COLLEGE, WITH YOUNG LABORATORY BUILDING TO THE LEFT.

The department of industrial arts is one not met with in many technical colleges. It comprises courses in house painting and decorating, ornamental metal work, lithographic drawing and design, modeling, cabinet making and furniture work.

The Weaving College is the outcome of a previous unsuccessful endeavor to found a technical college. Failing the whole scheme, this part was started, right in the heart of the weaving district, and

has already proved a great success. It contains 26 power and 20 hand looms fitted for all kinds of work, and lecture appliances to explain the intricacies of weaving.

Among the past professors the occupants of the chemical chair in Anderson College are perhaps best known, and include Dr. Birkbeck, Dr. Ure (author of "Dictionary of Arts and Manufactures,") Thomas Graham, Dr. Penny, Dr. Thorpe (now principal of Somerset House Laboratory), and Dr. Dittmar; among others may be mentioned Dr. Carey Foster (now Professor of Experimental Physics, University College, London), Prof. George Forbes, etc. Among famous students may be mentioned Dr. Livingstone, Lord Playfair, Dr. James Young (founder of the mineral oil trade in Scotland), etc. Among the present staff perhaps the most familiar names to electricians are Prof. Jamieson and Prof. Blyth, while the chairman, Sir



SOME OF THE ELECTRICAL APPARATUS.

John Neilson Cuthbertson, is one of the most progressive of Scotch educationalists.

It is scarcely possible in the limits of this article to do more than glance at some of the departments of the college, but this may give an idea of the varied and important work carried on by this institution. Any reader desiring to know more of the history of the college will find full information in an admirable book, "The First Technical College," by Prof. Sexton.

An Unjust Patent Statute.

BY ELIHU THOMSON.

Now that decided attention has been called, by the decision of the Supreme Court of the United States, interpreting Revised Statute No. 4,887, to the relations existing between patents taken out in the United States and abroad, it occurs to me that it would be interesting to note at this time some of the disadvantages under which the American inventor has labored in the past, and under which he still labors, and not only in so far as it concerns the taking out of patents, but also in relation to the publication of new matter or to the inventor's place in the history of an art.

While the decision of the Supreme Court makes it plain that the wording of the law in relation to the limitation of United States patents by foreign patents is to be taken instead of what would seem to me to have been the evident intent of the original enactment, I wish to point out some of the injustices under which the American inventor has suffered from this law, as it has been and is now interpreted, in comparison with inventors and workers abroad.

An American inventor making application for a patent has been and will still remain under the disadvantage of being required to perfect his United States patent before applying for patents abroad, and in order to secure valid patents abroad he must refrain from publication of any new matter which he may have discovered until such foreign patents have been obtained, as the mere publication nullifies the right to take a patent in most important foreign countries. But it is practically impossible, as is well known, under our system of patent examinations, to control the time of issuance of a patent in the United States, and if the application should become involved in an interference, which is more than apt to occur with inventions of any considerable importance, the issuance of a patent may be tied up for an indefinite period of years. During this period there is every prospect of the same subject matter being worked upon abroad, or the matter becoming published, especially if the invention undergoes development in the United States. The inventor, therefore, if he desires foreign patent protection must take his foreign patents and stand the shortening of the term of the United States patent; or, if the interference proceedings or other delays last during the life of the shortest foreign patent, he receives a patent which has already expired when it issues, a "still-born" patent, so to speak.

Again, in the race between two interfering inventions the weaker party finding that he will probably lose the interference in the United States may easily transfer his scene of activity to foreign countries, while the stronger party, feeling that he does not wish to ruin his United States interest at the same time refrains from patenting abroad. In this case the party who is likely to come out ahead here does come out at the last without any foreign patents, while the other party to the interference may come out with several valid foreign patents but no United States patent.

Now, I do not think it requires any argument to show that the evident intention of the United States law when it was first passed was not to bring about this state of things and so handicap the honest American inventor. Nor is this all. The position of the foreign inventor, under the United States law, has been that he could make his applications in foreign countries whenever he felt like doing so and receive his patents, and, after an indefinite period thereafter, he was at liberty to apply for a United States patent and obtain a patent only limited by the shortest term foreign patent. Prior publication here would not affect his rights. Prior publication does affect the United States inventor's rights abroad. Does not this amount to a discrimination against the United States inventor? And would it not really tend, were there not other favorable influences, to discourage invention here?

But there is still another point which I consider of the greatest importance. Owing to the conditions under the law as it exists, the United States inventor, no matter what the importance of his work may be, is debarred from publishing it until the issuance of his United States patent, which may take a year or two in the Patent Office, unless he is ready to forego some of the years of its life by taking out foreign patents at once after his United States application has been filed. He is, therefore, under restraint as to publication if he wishes to protect his foreign rights at all. And, let us ask, what has been the effect of this condition of affairs? Has it not been that an undue proportion of the history of many new advances, especially in the electric art, has been first published abroad? Has it not been that publications of new material have often been made abroad when in fact the same subject matter had been worked out here, in some cases years before? Does it not result in the credit for new work or the making of history, as it were, in a new art, being accorded in larger measure to workers abroad than would otherwise be the case? Now, suppose that instead of this law having existed at all, inventors who had made valuable discoveries or inventions were at liberty to apply for their United States patents and were equally at liberty to apply for at once and obtain, without prejudice to their United States rights, foreign patents on the same inventions, then they might freely publish at once their work and obtain the credit for it to which they are entitled, and which under the present condition of affairs has often been taken from them on account of the enforced delay of waiting for the issuance of the United States patents before applying for foreign patents. I have known it to be the case, and I have not the slightest doubt that others actively at work in the electric field have had the same experience, that the first entrance into the electrical literature of some new and important advance has been through the foreign publications, when, in fact, the broad subject had been worked over and was known for a long time previously here, but was withheld on account of this unfortunate state of patent laws in this country.

The United States is entitled to take its proper place, not only in the actual work acccomplished, but in the literature which naturally accompanies the work, and without such a restraint as now exists. The question arises, how long is the United States worker to be so handicapped, or practically put under a ban, by ill-considered laws? This is a question which I have often asked myself, and the answer to which, I have no doubt, has been sought by many who have experienced the same hardships.

Power Transmission.

BY OSSIAN CHYTRÆUS.

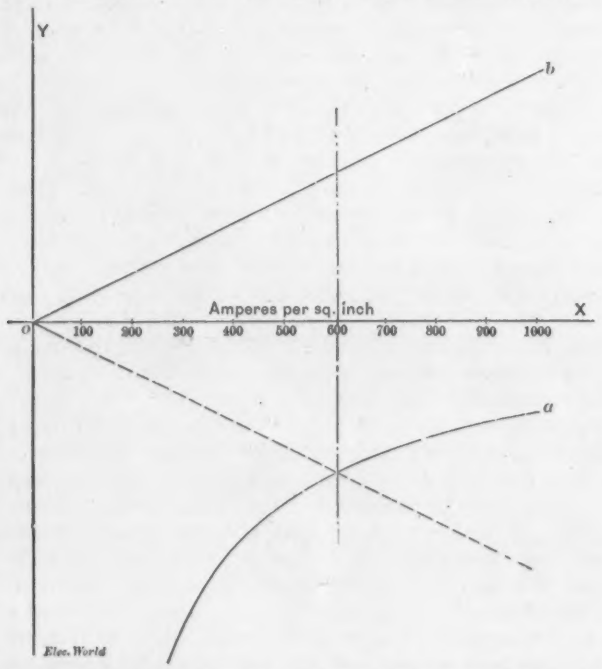
For power transmission of some length the best present engineering is to convert the power into electrical energy and through proper conductors transmit it to the place for it to be utilized or distributed. It is clear that the transmitting of power has an economical limit in regard to the distance, since the interest, depreciation and attendance of the stations and the line at a certain distance from the generating station make the power cost more at this point than if it were produced there by steam.

One of the factors which determine this distance is the kind and size of conductor. To get this of the proper dimensions is thus an important problem for an economical power transmission. We know that increasing the cross sectional area of the conductor for the same current decreases the power lost in the conductor and *vice versa*. If we then know the cost of the power lost in the line and also the cost of the conductor and the cost of such items as are proportional to an increased cross sectional area of the conductor, we can, by calculation, get the most economical size of the conductor.

The cost of power lost in the line is, if the power source is greater than our need, dependent upon the cost of the power at the terminals of the generating station. If the power at the generating station is not sufficient so that power must be produced by steam at the receiving station, the cost is dependent upon the cost of the electrical power produced at the receiving station by steam. If the power is not sufficient, but we do not wish to make up for the further need at the receiving station, the value of the power lost is fixed by the profit on the power at the receiving station plus the cost of the power at the terminals of generating station.

The cost of the erected conductor is fixed by the price of the conductor and such items as are proportional to the weight, as the freight to the place of its erection, the cost of the pole line, the work of erecting the line, etc., etc. The cost of the ground over which the pole line is going and the fencing in of the line, etc., have on the other hand, nothing to do with an increase of the cross sectional area of the conductor.

If we now, for a certain power transmission with a given E. M. F. for different current densities per square inch of cross sectional area of the conductor, figure the cost of the power lost in the line, the interest and depreciation on the cost of the copper and such items as are proportional to the increased conductor; then, for the current densities at which the sum of these is the smallest, the capital outlay is also the smallest for that power.



Relation Between Power Transmitted and Size of Conductor.

For this case let us assume that 1.000 kw are to be delivered 15 miles from a generating station at a voltage of 10,000. Further, let us assume that the yearly cost of an electrical kilowatt delivered to the line is $15, which includes buildings, the mechanical and electrical generating apparatus, step-up transformers and every item proportional to an increase of the installed capacity of the generating station.

Let us assume the cost of the copper for the line at the place of its erection to be 15 cents per pound, which includes such items as grow in proportion to an increased size of conductor. The interest and depreciation of the copper in the line we will assume to be 8 per cent. and the interest and depreciation of the generator station, etc., to be 10 per cent.

The values we get from the above data are represented in the accompanying diagram, where the ordinates of the curve *a-a* represent the interest and depreciation on the cost of the copper in the line, and the ordinates of the straight line *x-b* the cost of the power lost in line. The ordinates of *x-b* are proportional to the abscissæ when the ordinates of *a-x* are inversely proportional to the abscissæ. It is well known that they are least when they are equal, and this is, under the above conditins, at 605 amperes per square inch cross sectional area.

It can be seen from the diagram that the density per square inch of the cross sectional area of the conductor is independent of the power, the E. M. F. and the distance. This, however, may be made to appear more clear from the following explanation:

Call the power transmitted P watts, the E. M. F. E volts and the distance between stations K feet. Then the amperes in the line are $\frac{P}{E}$ and the cross sectional area of the conductor required for a density of X amperes per square inch is $\frac{P}{EX}$ square inch. The resistance of the line, if the resistance of one cubic inch of copper is a ohms, is:

$$\frac{X \times E \times K \times a \times 12 \times 2}{P} \text{ ohms.}$$

The watts lost in line are:

$$\frac{P^2}{E^2} \times \frac{X \times E \times K \times a \times 12 \times 2}{P}$$

$$\text{which reduces to } \frac{X \times P \times K \times a \times 12 \times 2}{E} \text{ watts.}$$

The value in dollars of these watts is, at b dollars per watt per annum,

$$\frac{X \times P \times K \times a \times b \times 12 \times 2}{E}.$$

The number of cubic inches of copper in line is, for X amperes per square inch,

$$\frac{P \times K \times 12 \times 2}{E \times X} \text{ cubic inches.}$$

The interest and depreciation in dollars on the cost of the copper in line are at c dollars per cubic inch,

$$\frac{P \times K \times c \times 12 \times 2}{E \times X}.$$

Then from the above, the most economical density is:

$$\frac{X \times P \times K \times a \times b \times 12 \times 2}{E} = \frac{P \times K \times c \times 12 \times 2}{E \times X} \qquad (1)$$

and

$$X \times a \times b = \frac{c}{X}$$

and finally.

$$X = \sqrt{\frac{c}{a \times b}} \qquad (2)$$

If now for a, the resistance of one cubic inch of copper, we substitute $\frac{7}{10^7}$; for b, the value per watt per annum of the power lost in the line, substitute $0.015; for c, the interest and depreciation per cubic inch of copper in line, substitute $0.00384, which values correspond to the above assumptions, we get 605 amperes per square inch.

When the current density per square inch is determined from equation (2), it remains to determine for what current load the actual cross sectional area shall be figured. We know that in a conductor the loss is proportional to the square of the current, and when, as is mostly the case, the maximum value of the current is far above the average working current, it is doubtful for what current load we should figure the conductor. At the generating station, the machinery, building, etc., must be for the maximum output, so that the factor due to this is nearly the same whether the full capacity is utilized or not. The cost of the power lost in line is, under these conditions, proportional to the resistance of the conductor. The cost of the conductor, on the other hand,

is inversely proportional to the resistance, and the sum of these two is least when they are equal.

Let the maximum current for a certain power transmission be I amperes. If we then in equation (1) substitute $\frac{E}{P}$ for I and figure the resistance R of the line, we get:

$$R = \frac{K \times c \times 12 \times 2}{X \times I \times b} \text{ ohm.}$$

This value of R we shall find corresponds to a cross sectional area of the conductor figured for the maximum current I with X amperes per square inch cross sectional area of the conductor, when X is determined from equation (2).

Electrical Execution.

At a meeting of the New York Prison Association in New York City last week, Dr. Augustin H. Goelet gave an account of his observations at the recent execution of the negro murderer Hampton at Sing Sing, and read the report of Dr. T. E. Oertel on a microscopical examination made of the blood and tissues of the executed criminal.

Dr. Goelet, in referring to the controversy recently excited by D'Arsonval's statement that the electric current as employed in the New York State prisons for the execution of criminals does not create absolute death, partly ascribed it to the apparently negative results of the official examinations of the bodies of the first six criminals executed by electricity at Sing Sing prison. Had the official pathologist, he said, who assisted at these post mortems not limited his examination of the brain to one case, he would have been able to discover what has only now, three years later, been demonstrated. Even in the single case when such an examination was made, it was admitted that minute extravasations of blood in the brain due to rupture of blood vessels were found, but not only did the report attach no special significance to this fact, but it was not even thought of sufficient importance to warrant a similar examination in any of the other five cases.

After giving abstracts from the report of himself and Mr. A. E. Kennelly in THE ELECTRICAL WORLD of Feb. 16, 1895, Dr. Goelet read the pathological report of Dr. Oertel on the examination of the blood and of tissues from various organs of the criminal. The deductions drawn by Dr. Oertel from his examination are as follows:

1. The chief action of the electric forces is upon the blood and the blood vessels.
2. The red blood corpuscles have less power of resistance to this force than have the white ones.
3. That one or more of the elements, the presence of which is required for the coagulation of the blood, is by the electric force changed or destroyed.
4. Some germicidal agent formed in the blood, precluding the continued existence and multiplication of putrefactive organisms.
5. The liver seems to be the organ, of those examined, most susceptible to the force exerted.
6. Of the organs examined, the lungs offered the most resistance to the force in question.
7. The force exerted is sufficient to rupture the brain tissues and the smaller vessels of the brain, thus producing universal hemorrhages in its substance.
8. No destruction of the cellular elements of the tissues seems to have been produced.
9. The deviations from the normal conditions, as noted, are sufficient to produce a lethal result.

In conclusion Dr. Goelet stated that death was instantaneous and apparently painless, which latter must be true, as electricity travels faster than the nerves can transmit painful impulses. The great and sudden rush of blood to the internal organs and to the cranial cavity was the cause of an enforced apoplexy which was overwhelming. This state of affairs was doubtless produced by the intense muscular contraction forcing the blood to the internal cavities where no resistance existed to oppose it, and the microscopical examination confirms this opinion, since it was found that the liver was engorged with blood, while the lungs, which are compressed by the diaphragm and chest walls, contained no unusual quantity of blood except in the upper part. It may, then, be confidently asserted that the death was painless, and if, therefore, murder, as the law declares, must be expiated by the death penalty, electricity should be universally adopted as a method of accomplishing this in the most humane manner.

Explosions in Underground Electric Mains and Suggestions How to Prevent Them.

BY ARTHUR SHIPPEY.

The many explosions in underground conduits which have recently taken place, and are becoming more frequent in all parts of the world, naturally set us all thinking as to what can be the actual cause of some of them. Therefore, in order to solve the problem we must consider the subject matter in all its bearings, and I think, to do this, that explosions in electric mains should be classed under three headings, viz.: 1. Those that are brought about by carelessness, which, of course, can be greatly reduced by more stringent rules being introduced and enforced to prevent them. 2. Those proved to be caused by short circuits, faulty fuses, corrosion, overheating of the main cables, sparking, etc. And, third, those that frequently mysteriously occur, the cause of which as yet remains unsolved.

Many suggestions, from time to time, have been promulgated by several of our scientists, both in England and abroad, but none, so far as I can learn, have ever suggested or even hinted at what I believe to be one of the real causes that has brought about several of these disasters which have so frequently occurred in various parts of the country in a most mysterious way. My "theory" is that many of these explosions which have taken place both here and on the Continent during the past ten years have been brought about under certain atmospheric conditions, and are caused by lightning flashes being conveyed to the earth through lightning conductors which need not—in order to cause an explosion—be fitted in the immediate vicinity where such explosions actually occur, for lightning waves are known to travel underground for many miles until they reach, or are absorbed, by water or damp earth, both of which have a great affinity for electricity. Then, again, it must not be forgotten that the principal thoroughfares of all large cities, in which the electric mains are being laid, are composed of a compound substance of a semi-metallic nature consisting of earth and pulverized metals brought into existence by reason of the wear and tear of thousands upon thousands of tons of iron tires, carriage wheels, horseshoes and other pulverized metallic substances, into which compressed compound there is laid a network of gas, water and bare copper electric mains, a combination of which forms an absolute and complete passage for the conveyance of the flashing currents. Therefore, this is one of the problems to be solved among others, and some method introduced by which explosions will be prevented from this cause in the future. I base my theory, which I claim to be fundamental, on the fact that many mysterious explosions have occurred in districts where thunder and lightning have been hovering about in the vicinity at the time. Hence, I am convinced that this is one of the real causes which has brought about the actual firing of explosive mixtures which naturally accumulate in the culverts and manholes of some systems.

I think Sir David Salamon's suggestion as to filling up the open spaces and manholes with small sand bags, in order to prevent excessive accumulation of explosive gas, a very good idea, and his plan should be thoroughly tried. In England, Major Cardew has called special attention in his recent reports to the importance of using proper fuses, and it is to be hoped that the Board of Trade and also insurance offices will now insist upon contractors being more particular as to the type of main fuses, also fuse links, used by them, for undoubtedly to the slipshod and makeshift manner this section of the industry is frequently scanted over in many instances, could be traced not only several explosions which have occurred in the mains, but also many of the mysterious fires which have occurred in electric circuits by reason of those faults which, if more carefully studied, would greatly tend to reduce the causes enumerated in category No. 2, as above described.

If you can spare space in your journal to record my views upon this subject, please do so, as the theory and suggestions made may assist in solving the problem relative to the causes of several very mysterious explosions which have occurred both in American underground electric mains, as well as those which are continually taking place on this side of the water. It would be interesting to obtain the views of American engineers versed on the subject, and whose ideas and experiences, if recorded, may throw more light on the subject, and thus assist in preventing these sad disasters and losses of life in the future, unfortunately brought about by reason of the leakage of gas from old faulty gas mains, known to exist in many districts where electric cables are continually being laid.

The Demand for Electrical Engineers.

BY FREDERICK H. FORD.

In a recent issue of a technical paper, devoted to the interests of electricity, there appeared an article, copied from the New York *Sun*, in regard to the demand for educated engineers. The writer made the statement that, in his opinion, the field of electrical engineering offered more promise of wealth and fame than "law, the grocery business, writing or knife grinding."

Although no editorial comment was made upon the article, its appearance in a technical paper would give added weight to the opinions of its writer in the mind of a young man making a choice of occupations.

A great mistake is being made in continually holding up the profession of the electrical engineer as one offering almost unlimited possibilities in the matter of salaries and demand for men. This mistake is most frequently made by persons who probably really know nothing whatever of the subject, and who are of the class who are continually making the statement that "electricity is in its infancy; and the laws which control its working are but little understood."

The aim of the present article is not to question the value of a technical education for the electrical engineer, but to give some facts in regard to the demand for young men with such an education.

At the present time there are probably not more than half a dozen entirely distinct companies in the country that would be able to furnish the entire electrical equipment for a plant for light or power of more than 500 hp capacity. In these large works the design and planning of both plants and machinery is under the immediate charge of two or three electricians who have a thorough understanding of the practical requirements of their work as well as the theories which govern it. The ideas which they furnish are carried out by the draughtsman in an almost purely automatic manner by the use of tables and slide rule. In the shop the work is carried on from working drawings, and no special knowledge of electricity is required. When the machines are tested for efficiency or other qualities, the work is done according to some scheme worked out by the chief electrician, and the results are worked out by means of formulæ selected by him to fit the case in hand. In many cases the persons making the test know nothing of the reasons for what they do. In the smaller factories the apparatus is often designed by some outside engineer. It is turned out from working drawings, and no attempt is made to test the machines in any way. Often there is no one in the factory who can, with justice, lay claim to the title of electrician.

In the central station for power and light we find the same conditions. The aim of the supply companies has been to turn out machines of the utmost simplicity of design and construction. To such a degree of perfection has this been carried that all parts of a machine liable to injury or wear are made interchangeable, and it only requires a fairly good mechanic to make what repairs are needed. The work of keeping the machinery running is a matter of such simplicity that almost any mechanic is thought equal to the task after a few months' experience.

The capital invested in the electrical industries of the country is largely in the form of stock companies. The larger companies have been gradually absorbing the smaller ones, and have united among themselves. This has lessened the demand for educated electricians, the executive departments of the companies uniting having been combined into one department. The closing down of many large works owing to financial trouble or patent litigation has also thrown a large number of men having both experience and ability on the market, thus causing the supply of engineers to be in excess of the demand. The struggle for place caused by this state of affairs has forced down the wages to such an extent that the average engineer will not receive a better salary than the head bookkeeper of a large wholesale concern.

The statement that for the average young man the field of electrical engineering offers more promise of success than "law, authorship, the grocery business or knife grinding," may be questioned.

He will be obliged to spend at least six years in preparation before he will be able to earn enough to barely pay his expenses, and during the greater part of this time he will be paying out money instead of earning it. The same time spent in preparation for either law or medicine would qualify him for beginning practice, while the time spent in business or journalism should find him in a good position. In the law or medicine he is working for himself, and he reaps the benefit of whatever success he may have. The young engineer will in most cases not have the capital needed to start in business for himself, and is forced to accept a subordinate position with some company.

Here he will get but a part of the profit coming from any success on his part, the greater share going to his employer, while he will suffer for his failures as much as if he were working for himself.

The young man choosing electrical engineering as a profession must do so with the understanding that he will have to work hard and long, and for wages which are not large in relation to the work done. For the young man who loves engineering enough to work for engineering, and not for wealth, there is as good a field in electrical work as in any branch of engineering. The idea that there are positions with large salaries attached waiting to be filled by him is a mistake. There are but few large salaried positions at best, and they are filled by men having large experience and influence with the capitalists back of the company.

The demand in electricity at the present time is not for educated electricians, but for educated capitalists; for men who will see that it is better to hire men who know why things should be done, and who will look after economy in the output, rather than to hire cheap men and waste the salary of a good man in inefficient methods of working.

When capital has been so educated, then and not until then will the relation between work done and pay received by the engineer compare favorably with that of the lawyer, the doctor, the writer and the merchant.

The Borchers Battery[1].

Dr. Borchers has replied in a recent number of the *Zeitschrift für Elektrotechnik und Elektrochemie* to the criticisms[2] which have been advanced on the cell devised by him for the direct production of electrical energy from the energy of gaseous fuel, and, seeing that the matter has led to a considerable amount of discussion in our correspondence columns, we append a translation of his letter defending his position:

On the Reactions in the Borchers Cell.

A reference appears in this journal (*Zeitschrift für Elektrotechnik und Electrochemie*) under the above heading, dealing with a criticism by Mr. Reed[3] of my paper read before the German Electro-Technical Society, or perhaps of an imperfect translation of it. I need not here repeat the objections urged by Mr. Reed, but may deal with them at once as follows:

1. With regard to the confusion which Mr. Reed supposes me to have made between cuprous chloride and metallic copper, I need do little but repel the insinuation as absurd. The behavior of a solution of carbon monoxide in cuprous chloride is thus described by C. Winkler in his text book on technical gas analysis:

"For the absorption of carbon monoxide a solution of cuprous chloride is used, with which the gas forms a compound Cu_2Cl_2CO. The cuprous chloride can be used either in acid or ammoniacal solution; but the latter is generally to be preferred, as the carbon monoxide in presence of excess of ammonia gradually yields ammonium carbonate and metallic copper, which is deposited on the walls of the absorption vessel. The reaction takes place according to the equation,

"$Cu_2Cl_2CO + 4NH_3 + 2H_2O = 2Cu + 2NH_4Cl + (HN_4)_2CO_3$; and has as its result a continual suppression of the carbon monoxide absorbed, and also the protection of the solution from oxidation by the presence therein of the metallic copper which is correspondingly deposited."

2. I not only thoroughly recognize the possibility of the reaction expressed by the equation $O + Cu_2Cl_2 + 2HCl = 2CuCl_2 + H_2O$, but I have actually indicated that this equation is likely to occur primarily in the cathode compartment, as may be seen by reference to an article in the *Chemische Industrie*, XXII., November 15, 1894.

The final and sole product of my gas cell is never cupric chloride when its working takes place normally. We have seen above that carbon monoxide possesses the power of depositing copper from a solution of a cuprous salt, being itself oxidized to carbon dioxide, as may be demonstrated by taking the equation

[1] From the London *Electrician*.
[2] See THE ELECTRICAL WORLD (Digest). Nov. 10, Dec. 8, 15, 29, 1894.
[3] See THE ELECTRICAL WORLD of Dec. 22, 1894, in which the article of Mr. Reed originally appeared.

quoted above from Winkler, and eliminating all that is not essential to its occurrence. It then becomes

$$(\alpha)\ Cu_2Cl_2 + CO = Cu_2Cl_2CO, \text{ and}$$
$$(\beta)\ Cu_2Cl_2CO + H_2O = Cu_2 + 2HCl + CO_2.$$

Disregarding the presence of ammonia, a solution has been prepared by the action of carbon monoxide, capable, under certain circumstances, of depositing copper. These circumstances consist chiefly in the avoidance of the formation of too much free hydrochloric acid. Ammonia neutralizes hydrochloric acid. The reaction given by Reed also needs hydrochloric acid, thus:

$$O + Cu_2Cl_2 + 2HCl = {}^2CuCl_2 + H_2O.$$

If, then, we were to take this reaction to represent that occurring in the cathode compartment, and the former pair of equations for those taking place in the anode compartment and regard them as primary, or if we were to have in two vessels completely separated from one another cuprous chloride treated with carbon monoxide in the one and cuprous chloride saturated with air in the other, and were to unite these two liquids to form a circuit the reaction would then doubtless occur according to the equation $Cu_2 + 2Cu_2Cl_2 = 2Cu_2Cl_2$. In fact, a cell would be formed from the action of cupric chloride upon copper regarded as reduced by the carbon monoxide. I need scarcely cite an authority to justify the statement that cuprous chloride is formed by the action of cupric chloride upon copper, whether as actual metal or regarded as separated from solution. If, then, the four fundamental equations be added together, thus

$$Cu_2Cl_2 + CO = Cu_2Cl_2CO$$
$$Cu_2Cl_2CO + H_2O = Cu_2 + 2HCl + CO_2$$
$$Cu_2Cl_2 + 2HCl + O = 2CuCl_2 + H_2O$$
$$2CuCl_2 + Cu_2 = 2Cu_2Cl_2$$

their arithmetical sum will be found to be $CO + O = CO_2$.

3 and 4. These points have been in great measure dealt with. It is obvious that if carbon monoxide be absent, or present in insufficient quantity, the oxygen of the air will produce an undue amount of cupric chloride which will, of course, favor the solution of the copper as cuprous chloride according to the equation already quoted. It is not to be wondered at that approximately the same current can be obtained when carbon monoxide is not used, considering the small output of current and the possibility of the formation of copper and cupric chloride, but in that case the current is obtained at the cost of the copper composing the apparatus; that is, according to a method possible indeed but not proposed by me. Mr. Reed's remaining remarks can be dealt with together with those made by Robert Mond[4] in No. 869 of the *Electrician*. The last-named investigator has experimented with various combinations and collected the results of his measurements in the following table:

Anode.	Solutions.	Cathode.	Volts.
(1) Carbon.....	Hydrochloric acid, 25 per cent.....	Copper....	0 6006
(2) Carbon	Cupric chloride in hydrochloric acid.....	Copper....	0.4655
(3) Carbon	Cuprous chloride in hydrochloric acid ...	Copper....	0.3774
(4) Carbon	Carbon in copper oxychloride in HCl.... / Copper in cuprous chloride in HCl.....	Copper....	0 4315
(5) Carbon	Carbon in copper oxychloride in HCl .... / Copper in copper carbonic oxide chloride in hydrochloric acid.	Copper....	0.4407
(6) Carbon	Carbon in cuprous chloride in HCl and air. / Carbon in cuprous chloride in HCl and carbonic oxide.	Carbon....	0.0015
(7) Carbon	Carbon in cuprous chloride and HCl and air. / Carbon in cuprous chloride in HCl and coal gas.	Carbon.	0 0050

At the end of the table is the remark "these figures seem to me to throw a strange light upon the source of electricity in Dr. Borchers' cell." No details are given as to the method of carrying out the experiments; such details are especially to be desired for experiments 6 and 7. Experiments 1 to 5 support the view, already mentioned, that the first action of the oxygen at the cathode is to form cupric chloride, and the first action of the carbon monoxide tends to cause the separation of copper, so that the voltage measured is that proper to the action of cupric chloride on metallic copper. As regards experiments 6 and 7, I may say that I have not concealed that at first I worked with two carbon electrodes. But it very soon became clear to me that a carbon electrode is an excellent transferrer of oxygen, but does not similarly favor the solution of carbon monoxide; on the contrary, unless particular care be taken to remove all oxygen from a carbon plate previously exposed to air and to keep it free from contact with all air during the working of the cell, such a plate would, if only one part of it were in contact with the air, be capable of bringing oxygen directly, at the anode, to the carbon monoxide or to the copper regarded as separated thereby; to judge by the results, this appears to have happened in Mr. Mond's experiments. On account of these difficulties I have abandoned the use of a carbon electrode in the anode compartment; the exclusion of oxygen, which is necessary, would increase the technical difficulties of construction. When the use of copper is substituted for that of carbon, precautions must merely be taken so that the carbon monoxide prevents the attack of the copper thus employed. Whether that be possible in a large scale plant must be decided by further experiments. But yet another consideration restrained me from the use of two carbon electrodes. Mr. Mond has had the goodness to support my decision by his experiments quoted above. (1) According to his second experiment, the circuit "carbon—cuprous chloride—copper" gives a voltage of 0.3774. (2) On the other hand, however, according to the experience of all gas analysts, a solution of carbon monoxide in cuprous chloride tends to deposit copper. But if we examine the condition of experiments 6 and 7 it is plain that here are three substances present in the anode compartment; viz., copper (regarded as separating from the solution), cuprous chloride, and carbon, which, according to Mr. Mond's second experiment, themselves constitute a cell. It is to be understood that I would not withhold any further experimental results whether favorable or the reverse. But I must ask for some consideration if delay occur. Besides my ordinary occupation, I have a good deal of literary work to be completed in the first half of this year, thus absorbing the whole of my time. I am therefore obliged to put off further experiments until I can give them my whole attention. I must beg those who make trial of my cell to turn to the original paper, and not to trust to translations. I must also request those who publish experiments which are unfavorable in tend ency to describe the conditions of experiment accurately. Discussion is otherwise valueless.

[4] See the ELECTRICAL WORLD (Digest), Feb. 2, 1895.

In the same number of the *Electrician* appears the following letter from Mr. H. H. Barnes, Jr.:

Dr. Borchers' long-looked-for statement in defence of his element having appeared in No. 15 of the *Zeitschrift für Elektrotechnik und Elektrochemie*, a few further remarks on the subject in connection with it may be of interest.

Passing over in utter silence the hydrochloric combination, with which, it will be remembered, he originally obtained the best results, he deals exclusively with the processes in a cell with ammonia as solvent, and advances the following equations as of primal importance:

$$Cu_2Cl_2CO + 4NH_3 + 2H_2O = Cu_2 2NH_4Cl + (NH_4)_2CO_3. \quad (1)$$
$$Cu_2Cl_2\,CO + H_2O = Cu_2 + 2HCl + CO_2 \quad (2)$$
$$Cu_2Cl_2 + 2HCl + O = 2CuCl_2 + H_2O \quad (3)$$
$$2CuCl + Cu_2 = 2Cu_2Cl_2 \quad (4)$$

Eliminating from (1), a generally accepted equation, "all that does not really change," he deducts (2), and from (2)—(4), which are given without taking account of the presence of ammonia, he concludes that the sum total of *all* the reactions amounts practically to $CO + O = CO_2$.

Now, (2) is contrary to facts, and can only stand as (1) with NH_3 in abundance, in which case $(NH_4)_2CO_3$ is the final product, of the element, and not CO_2 as such. This is a most vital difference, and not to be overlooked; but it is by no means the only vulnerable point.

It will be seen from (1), (3), partially altered, and (4) that theoretically no copper is consumed; but then (3) is only one of many ways in which higher salts can be formed, among others being, for instance,

$$3Cu_2Cl_2 = 3O = Cu_4Cl_2O_3 + 2CuCl_2.$$

It is, therefore, evident that, not being able to confine chemical action to the processes given in (1)—(4), the copper plates will be attacked by the $CuCl_2$ formed in other ways, and this with telling effect, as the salts resulting from (1) greatly facilitate corrosion.

Taken as a whole, Dr. Borchers' article contradicts his former statements, as his own equation (1) not only gives $(NH_4)_2CO_3$ and not merely CO_2 as final combination, but he also says: "It must be left to future experiments to decide if elements (Betriebs-elemente) can be constructed in which copper is not

attacked," whereas four months ago he laid great stress on the fact that no noticeable decrease in weight was ever observed.

From the above it will appear that it was premature to say his cell would undoubtedly remain prototype.

Electricity Direct from Fuel.

BY C. J. REED.

The expression "electricity direct from fuel" is understood to mean the conversion of the energy of fuel into electrical energy without the intervention of a thermo-dynamic or a thermo-electric process, that is, without any operation that necessitates the primal degradation of the energy into heat.

In this sense any primary battery evolving electrical energy from zinc or other metals reduced by fuel to the metallic state produces electricity direct from fuel. But this is not the sense in which the expression is generally used. This galvanic process has always necessitated the splitting up or destruction of chemical reagents that either become waste products or require a costly and continuous regeneration.

The expression commonly and almost invariably refers to a problem the practical solution of which has not yet been published, if it is known. The problem may be stated as follows:

The conversion of the energy of fuel (including fuel gases, such as carbon monoxide and hydro-carbons) into electrical energy by oxidation without transforming the energy into heat and without the destruction of chemical reagents or the formation of waste products that require regeneration.

Numerous attempts have been made to oxidize carbon electrodes by fused oxidizing agents, such as nitrates, chromates, etc., also by oxidizing solutions. But it is evident that such attempts are not even in the right direction, as they all involve the destruction of chemical reagents that make the operation more expensive than the zinc battery.

Others have attempted to solve the problem by a sort of thermo-galvanic process in which a set of chemicals and electrodes are alternately heated and cooled, absorbing heat during the first and evolving electric current during the second of these operations. If success should be attained in this direction it could evidently be nothing better than the conversion of heat into electrical energy, which is not the problem under discussion here.

Perhaps the most absurd of all attempts to solve this problem are those in which a set of reagents and electrodes are supposed to evolve electrical energy while being heated and then absorb energy while cooling, by a reversible chemical reaction which does not take place. Such a battery is described by Mr. S. Skinner, in the *London Electrician*, of Feb. 15, 1895, "On the Tin-Chromic Chloride Cell." (See THE ELECTRICAL WORLD Digest, March 9.)

So far the only real attempts to solve the problem, as stated above, are those in which fuel gases and oxygen gas were supposed to combine in contact with incorrodible electrodes, such as platinum or carbon. In the presence of platinum black there is no question that this reaction takes place at least in the case of hydrogen. It was probably obtained by Grove and other early investigators. It was undoubtedly obtained by Heringand Dobrowolsky in 1883. (See ELECTRICAL WORLD, Feb. 23, 1895, page 220.)

But it has not yet been demonstrated that this reaction takes place in presence of plain carbon electrodes, nor even with platinum electrodes in the absence of platinum black. To test this question in regard to oxygen and hydrogen, the writer has tried an experiment which will be described in the near future.

The most sensational announcement that has appeared recently relating to this subject was the paper by Dr. Borchers, read before the German Electro-Chemical Society in October, 1894 (see also THE ELECTRICAL WORLD Digest, Dec. 8, 1894), in which he claims to have obtained the direct cold combustion of carbon monoxide and other fuel gases in contact with a solution of cuprous chloride in hydrochloric acid without the use of platinum black, using only carbon and copper electrodes.

By ignoring the actual chemical reactions which took place he inferred that the energy of his battery was due to the direct combination of carbon monoxide and atmospheric oxygen. On the strength of this error he calculated that he had produced electrical energy by the direct combination of carbon monoxide and atmospheric oxygen with an efficiency between 26 and 38 per cent. He also mentions that another similar battery containing an alkaline instead of an acid solution of cuprous chloride gave similar but inferior results. With this statement he dismisses the alkaline battery as being worthy of no further notice.

In a communication to THE ELECTRICAL WORLD of Dec. 22, 1894, the writer pointed out the fallacy of Dr. Borchers' inferences, and showed the source of electrical energy to be the action of the chemicals used upon the copper electrode, and also that the same results could be obtained without any fuel gases.

As Dr. Borchers had dismissed the subject of the alkaline battery without giving any figures and without making any claim for it, I did not consider it necessary to allude to it in my former communication.

Since that time a number of investigators have tried the experiment, as I suggested, both with and without the fuel gases.

Their results, most of which have been published in the *London Electrician* and abstracted in the Digest of THE ELECTRICAL WORLD, all confirm my original statements in regard to the Borchers battery.

But Dr. Borchers dies hard. He appears to be one of those who, "convinced against his will, is of the same opinion still."

In a recent number of the *Zeitschrift für Elektrotechnik und Elektrochemie*, translated in the *London Electrician* of Feb. 22, 1895 (see above.—ED.), Dr. Borchers, while denying it in words, admits, so far as any evidence to the contrary is concerned, that the hydrochloric acid battery which he had described, and on which his claims were based, is a mistake. It is natural that he should wish to let himself down easily. He, therefore, abandons his acid battery, and with considerable exertion shows that my criticisms do not apply to the alkaline battery which he did not describe, and on which he has not yet given the public any figures. Evidently he still tries to believe that he has produced electricity by the direct combination of carbon monoxide and atmospheric oxygen. This belief seems reasonable for one who, like Dr. Borchers, has not given proper attention to the chemical reactions involved, and has drawn all his conclusions from the fact that with a certain arrangement of apparatus and chemicals he obtains an electromotive force of 0.56 volt.

In commenting on this subject the editor of the *London Electrician* strikes the keynote in the following words: "Qualitative observations such as have been published are, in a matter of this kind, worse than useless. They darken counsel. It does not suffice to record the current and voltage obtained; a complete chemical balance sheet must be made out."

Examining Dr. Borchers' new balance sheet we find he now relies on the following equation quoted from Winkler:

$$Cu_2Cl_2CO + 4NH_3 + H_2O = 2Cu + NH_4Cl + (NH_4)_2CO_3$$

A mere inspection of this equation should have convinced Dr. Borchers that no atmospheric oxygen or oxygen from any source except from water takes part in this reaction. The oxidation is accomplished solely by the decomposition of water and reduction of cuprous chloride to metallic copper, the reaction being exactly equivalent, so far as the electric current is concerned, to the reduction of cuprous oxide to metallic copper in the well-known copper-zinc alkaline accumulator. In the copper-zinc accumulator the cupric oxide is reduced first to cuprous oxide and then to metallic copper, and the reduction of one grain of cuprous oxide is equivalent to 0.36 ampere-hour at about 0.6 to 0.7 volt, or about 0.23 watt-hour; while in Dr. Borchers' "direct" battery which he now proposes the reduction of one gram of cuprous chloride is equivalent to only 0.27 ampere hour at probably not over 0.4 volt (he gave no figures on this battery), or 0.11 watt-hour.

That this arrangement of Dr. Borchers is a primary battery I do not think there is any reason to doubt. But that it is not a battery in which the electrical energy is derived from the combination of carbon monoxide and atmospheric oxygen is equally evident.

There is nothing remarkable in the oxidation of carbon monoxide by an oxidizing agent, such as chlorine, cuprous chloride (which, in this case acts as an oxidizing agent), chromic acid, etc., but this is not the problem Dr. Borchers claimed to have solved.

As to the direct combination of carbon monoxide and oxygen in absence of platinum black, or even in presence of platinum black, it still remains to be proved.

I would, in this connection, call attention to the observation Remsen and Southworth (Sill. Amer. J. [3], xi., 136) that carbon monoxide is not oxidized even by ozone, either in diffused daylight or direct sunlight.

The following is a complete list of references, as they appeared in our "Digest," to all the articles which have appeared on this subject: Nov. 10; Dec. 8, 15, 29; Feb. 2, 9, 16, 23; March 2. Allied articles on the same general subject of gas and heat batteries were abstracted or referred to in the "Digest" July 21, Sept. 15, Oct. 6, Dec. 8, 15, 22; Jan. 5, Feb. 2, 16; March 9.

Electrical Power Transmission.—XVI.

BY LOUIS BELL, PH.D.

Before taking up the practical task of line calculation it is necessary to consider somewhat at length the electrical difficulties that must be encountered and which impose limitations on our practically achieving much that in itself is desirable and useful. We have seen already that the secret of long distance transmission lies in the successful employment of very high voltages, and whatever the character of the current employed the difficulties of insulation constantly confront us. These are of various sorts, for the most part, however, those that have to do with supporting the conducting line so that there may not be a serious loss of current via the earth. Next in practical importance come those involved in insulating the conductor as a whole against, first, direct earth connections or short circuits in underground service, and second, ground or short circuits, if the line is an aerial one.

In a very large number of cases no attempt is made to insulate the wire itself by a continuous covering, and reliance is placed entirely on well-insulated supports. In most high voltage lines this is the method employed, partly for economy and partly because there is well-grounded distrust in the durability of any practicable covering under varying climatic conditions and the constant strain imposed by high voltage currents.

So far as supports go, it is evident that while the individual resistance of any particular one may be very great, the total resistance of all those throughout the extent of a long line to which they are connected in parallel to the earth may be low enough to entail a very considerable total loss of energy. The possibility of such loss increases directly with the number of supports throughout the line. The most obvious way of reducing such losses would be to considerably increase the distance between supports. This process evidently cannot go on indefinitely, for mechanical considerations, and hence the greatest advance can be made in reducing the chance of loss in individual supports.

Most of the present practice consists merely of an extension of the methods that were devised for telegraphic work. These were quite sufficient for the purpose intended, but are inadequate when applied to modern high voltage work. The ordinary line consists, then, of poles bearing on pins of wood or metal secured to cross arms, bell-shaped glass or porcelain insulators. To grooves on or near the top of these the line wire is secured by binding wire. Loss of current to earth in a line so constituted takes place in two ways. First, the current may pass over the outer surface of the insulator, up over the interior surface, thence to the supporting pin and so to earth. Second, it may actually puncture the substance of the insulator and pass directly to the supporting structure.

The first source of trouble is the commoner and depends on the nature and extent of the insulating surface, and even more on climatic conditions. The second depends on the thickness and quality of the insulating wall which separates the wire from the pin. To avoid leakage an insulator should be so designed that, first, the extent of surface shall be as long and narrow as possible; second, that this surface shall be both initially and continuously highly insulating. The first condition is met by making the insulator of comparatively small diameter and adding to the length of the path over which leakage must take place by placing within the outer bell of the insulator one or more similar bells (usually called petticoats). These not only help in the way mentioned, but they are likely to be tolerably dry even when the exterior surface is wet, and thus help to maintain the insulation.

A good glass or porcelain insulator made on these general lines gives excellent results with ordinary moderate voltages, say up to 3,000 volts. When the insulators are new and clean they will quite prevent perceptible leakage and for the voltage mentioned are satisfactory under all ordinary conditions. When higher voltages are employed the results may be at first good, but they are unlikely to stay so unless the climatic conditions are exceptionally favorable. Most glass permits a certain amount of surface leakage, even when new, although generally not enough to be of practical importance, but even the best of it weathers when exposed to the elements, so that in time the surface becomes slightly roughened and retains a film of dirt and moisture that is a very tolerable conductor. Even while perfectly free from this deterioration at first, it is generally hygroscopic, because it is in a trifling degree soluble even in rain water, and tends to retain a slight amount of moisture. Thus in damp climates glass is likely to give trouble when used on a high voltage line. As regards temporary fall in insulating properties a searching fog or drizzling rain is worse in its effects on insulators than a sharp shower or even a heavy rain, which tends to wash the outer surface free of dirt, and affect the comparatively clean interior but little.

Much cheap porcelain is also hygroscopic owing to the poor quality of the glaze, and it has the considerable further disadvantage of depending on this glaze for much of its insulating properties. Glass is homogeneous throughout its thickness, while porcelain inside the glaze is porous and practically without insulating value. Nevertheless porcelain which is thoroughly vitrified, the ordinary glaze being replaced by an actual fusing of the surface of the material itself, is decidedly preferable to glass, being tough and strong, quite non-hygroscopic and of very high insulating value. The surface does not weather and the insulation is well kept up under all sorts of conditions. If the vitrification extends, as it should, considerably below the surface, the insulator will resist not only leakage, but puncture, better than any glass. The process of making this quality of porcelain is somewhat costly, since the baking has to be at an enormous temperature and long continued, but the result is the most efficient insulating substance in use.

Surface leakage is more to be feared than puncture at all voltages, since the absolute insulation strength of the material can be made high enough by careful attention to quality and sufficient thickness to withstand any voltage within our command, and that continuously barring mechanical injury. But leakage can never be depended on; it is a function of moisture, drifting dust, and things meteorological generally, besides which, it can take place in serious amount at voltages which otherwise would be very easy to work with.

As the result of all recent experiments, it may be confidently stated that danger from actual breaking down of the insulation by puncture need not be at all feared up to certainly 15,000 volts with any good modern high voltage insulator. With the best insulators at present attainable the voltage just mentioned can easily be doubled without serious danger of breaking through the material.

At such high electrical pressures, however, the difficulty of stopping surface leakage becomes formidable, especially in bad weather. Glass insulators become almost useless, and only the best porcelain is to be trusted—even this with some reservations. To reinforce the insulation of the surface it has been quite usual to take recourse in the extraordinary insulating properties of heavy mineral oil. Imagine the lower edge of the outer bell of any insulator folded inward so as to form a deep groove opening upward all around the insulator. Fill this hollow with oil and it is evident that if surface leakage takes place at all it must be across the surface of this oil. Various modifications of this plan will be shown later.

Such an oil insulator is quite free from surface leakage so long as the oil surface is kept clean and in good condition. This is, however, very difficult to do and there is great danger that the oil surface from the combined action of dirt and moisture will degenerate into a species of conducting slime. Where dust is very prevalent the oil is specially likely to give trouble; it is far better able to cope with moisture alone than with moisture *plus* dust. From what has been said it is clear that line insulation is largely a matter of climate. Where it is uniformly warm and dry almost any kind of insulator will suffice, provided the material has tolerable insulation strength and the insulator is of passably good design. With a climate foggy in summer and sleety in winter even the best porcelain insulators will be severely tried at high voltages.

The record of what has actually been done in the transmission of electrical energy at high voltages is comparatively short, and gives no very valuable data for the important work over long distances that must be done in the next few years. The experience with arc light circuits at 5,000 volts or above, working over lines from 20 to 40 miles long, is already considerable. Seventy-five to 125 light dynamos are now common, the latter giving in the vicinity of 6,250 volts, and this from open-coil armatures of which the maximum voltage is roughly equal to that of an alternator of the same nominal voltage. The lines are usually, almost always, of wire having no very high insulating properties, supported on common glass insulators, often without an interior petticoat. One hundred and fifty light generators are in occasional use and now and then two machines of 75-light capacity or more are operated in series for considerable periods. This practice is commoner than is generally supposed.

Alternating circuits of 5,000 volts or more are now not at all uncommon either here or abroad. Several of them have been in operation long enough to be thoroughly tested. An 18-mile trans-

mission at a little over 5,000 volts, to Guadalajara, Mexico; an 11-mile 5,000 volt line to Hartford, Conn.; another (three-phase) 14 miles to the works of the Oelikon Company, at 7,700 volts, and the Tivoli-Rome plant, 18 miles at 5,000 volts, have been in steady and successful operation for two years or more. A number of others, probably a score in all, of less prominence, owing to shorter length of lines and smaller capacity, are in regular operation at 5,000 to 6,000 volts. Most of the lines are of bare copper wire supported on oil insulators of glass or porcelain. They have been uniformly free from all serious trouble.

In the vicinity of 10,000 volts the experiments are fewer but none the less conclusive. Only two commercial plants have been regularly operated at such a pressure. One is the well-known Ferranti station working a 10,000-volt main from Deptford to London, about 11 miles, and using a concentric underground cable. The plant has experienced various vicissitudes and has not been steadily operated, but the troubles are not generally chargeable to the mains, which have, however, been a little uncertain in their performance. The other case is the lighting plant in San Antonio Canyon, California. This consists of a single alternating generator of 150 kw at 1,000 volts. Raising transformers establish a line pressure of 10,000 volts, at which current is transmitted to Pomona, 16 miles distant, and to San Bernardino, 28 miles. At each of these places is a substation with reducing transformers and regulating apparatus. The current is used exclusively for lighting and the plant has been in thoroughly successful operation for a couple of years. The line is of bare copper supported on good-sized, double-petticoat glass insulators without oil. There has been practically no trouble from leakage, even during the winter, when rains are of almost daily occurrence, no insulators have been punctured, and the only trouble on the line has been of a very trifling character and due to accidental causes, such as a tree branch, an occasional insulator broken by a charge of shot and the like. The line has been worked long enough to develop any probable latent troubles, and is a sufficient demonstration of the entire practicability of 10,000-volt transmission of energy, at least in a favorable climate.

Of systems operated at more than 10,000 volts there are at present none, but experiments have been not infrequent and generally successful. The most noted of these is the Lauffen-Frankfort line, 108 miles long (three-phase), worked somewhat irregularly during the latter part of the summer of 1891. Operations were generally at 13,800 volts, though on a few occasions this was temporarily doubled. There was no noticeable leakage, but an insulator was now and then punctured even at the lower pressure, producing a tiny, irregular hole clear through from the neck of the insulator to the supporting pin. The insulators which supported the bare copper line were of porcelain with oil grooves. The line worked well in all sorts of weather, but the total period of operation was too short to give this brilliant experiment much value as a precedent.

Most of the large electrical manufacturing companies have during the last few years carried on experiments on high-voltage transmission, mostly with short lines near their factories. The range of voltages has varied from 10,000 to 25,000 or 30,000, and the concurrent experience has been that at the lower pressure mentioned successful working can be attained under almost any circumstances. At 15,000 volts indications were still very favorable, but at pressures of about 20,000 insulation begins to be very troublesome, both from extensive leakage in bad weather and occasional puncture. Here porcelain shows its marked superiority and special insulators of this material can be depended on to keep down leakage and resist puncture at more than 20,000 volts under ordinary circumstances. There has not yet been enough experimentation at these higher limits to determine the probable effects of time and bad weather.

Let us now sum up our present knowledge of the transmission of electrical energy over high-voltage lines. From a considerable amount of experience, we are sure that there is no real difficulty in establishing and maintaining adequate insulation of either direct or alternating currents up to an effective pressure of 10,000 volts. Above this the experiments are less conclusive, but there is good reason to believe that satisfactory results can be reached up to 15,000 without very extraordinary precautions. With good climatic conditions 20,000 or 25,000 may be considered practicable, but certainly involve unusual precautions not yet determined by experience.

At still higher voltages the difficulties are likely to multiply rapidly, and a point will ultimately be reached at which the cost of insulating devices will overbalance the saving of copper due to increased voltage. This point is at present indeterminate, and will always depend on the amount of power to be transmitted, the permissible loss in the line and unknown variables involving repairs and depreciation, cost and depreciation of transformers and so on. It is quite impossible from present data to set such a limit even approximately, for we know as yet nothing of the relative difficulty of insulating voltages considerably above the range of our experience. Only guesses are in order as to the availability of very high voltages. Personally, the author would not hesitate to undertake a transmission at 50,000 volts effective pressure in a climate like that of Southern California, with the full belief that the task would be successfully accomplished. The next few years will show great progress in this direction.

(To be continued.)

Practical Notes on Dynamo Calculation—XXIX.

BY ALFRED E. WIENER.

Chapter 49. *Dimensioning of Magnet Cores.*—The sectional area of the magnet cores being found by means of the formulæ and tables given in Chapter 48, their *length* and their *relative position* must be determined.

(*a*) *Length of Magnet Cores.*

In the majority of types the length of the magnet cores has a more or less fixed relation to the dimensions of the armature, and definite rules can only be laid down for such cases where the length of the magnets is not already limited by the selection of the type.

Two points have to be considered in dimensioning the length of the magnets. The longer the cores are made, the less height will be taken up by the magnet winding; the mean length of a convolution of the magnet wire and, consequently, the total length of wire required for a certain magnetomotive force will, therefore, be smaller the greater the length of the core. On the other hand, the shorter the cores are chosen the shorter will be the magnetic circuit of the machine, and, in consequence, the less magnetomotive force will be required to set up the necessary magnetic flux.

Of these two considerations—economy of copper at the expense of additional iron on the one hand, and saving in magnetomotive force and in weight of iron on the other—the latter predominates over the former, from which fact follows the general rule to make the cores as short as is possible without increasing the height of the winding space to an undue amount.

In order to enable the proper carrying out of this rule, the author has compiled the following Table LXIII., which gives practical values of the height of the winding space for magnets of various types, shapes and sizes.

TABLE LXIII.—HEIGHT OF WINDING SPACE FOR DYNAMO MAGNETS.

Size of core.		Bipolar types.				Multipolar types.			
		Cylindrical cores.		Rectangular or oval cores.		Cylindrical cores.		Rectangular or oval cores.	
Diameter of circular cross section.	Area of rectangular or oval section.	Height of winding space.	Ratio of winding height to diameter of core.	Height of winding space.	Ratio of w'd'g height to diam. of equal circular section.	Height of winding space.	Ratio of winding height to diameter of core.	Height of winding space.	Ratio of w'd'g height to diam. of equal circular section.
Inches.	Sq. ins.	In.		In.		In.		In.	
1	.8	½	.50	...	....	¾	.75	...	....
2	3.1	¾	.375	1	.50	1¼	.625	1½	.75
3	7.1	1	.33	1¼	.42	1½	.50	1⅞	.625
4	12.6	1¼	.31	1⅝	.41	1⅞	.47	2¼	.56
6	28.3	1½	.25	2	.33	2¼	.375	2⅝	.44
8	50.3	1¾	.22	2½	.31	2⅞	.36	3	.375
10	78.5	2	.20	2¾	.275	3¼	.325	3½	.35
12	113.1	2⅛	.18	3	.25	3⅝	.30	4	.33
15	176.7	2¼	.15	3¼	.22	4	.27	4½	.30
18	254.5	2⅜	.13	3½	.20	4⅜	.24	5	.28
21	346	2½	.12	3¾	.18	4⅞	.23	5½	.26
24	452	2⅝	.11	4	.17	5¼	.22	6	.25
27	573	2¾	.10	4¼	.16	5¾	.215	6¼	.25
30	707	3	.10	4⅜	.15	6¼	.21	7½	.25
33	855	3¼	.099	5	.15	6¾	.205	8¼	.25
36	1018	3½	.097	5½	.15	7¼	.2	9	.25

In *bipolar* machines, such as the various horseshoe types, in which the length of the magnet cores is not limited by the form

the field magnet frame, the radial height of the magnet winding in case of *cylindrical magnets* varies from one-half to one-tenth the core diameter, according to the size of the magnets, and, in case of *rectangular* or *oval* magnets, is made from .5 to .15 of the diameter of the equivalent circular cross-section. For *multipolar* types, in which the length of the magnets is of a comparatively much greater influence upon size and weight of the machine, it is customary to set the limit of the winding height considerably higher, in order to reduce the length necessary for the magnet winding. For *cylindrical* magnets to be used in multipolar machines, therefore, the practical limit of winding height ranges from .75 to .2 of the core diameter, and, for *rectangular* or *oval* magnets, from .75 to .25 of the diameter of the equivalent circular area according to the size.

In case of emergency the figures given for *rectangutar* cores may be used in calculating *circular* magnets, or those given for *multipolar* types may be employed for *bipolar* machines.

In order to keep the winding heights within the limits given in Table LXIII., the lengths of *cylindrical* magnets have to be made from 3 to 1 times the core diameter for *bipolar* types, and from 1 to ½ the core diameter for *multipolar* types; those of *rectangular* magnets from 1⅔ to ¾ the equivalent diameter for *bipolar* types, and from 1¼ to ⅔ the equivalent diameter for *multipolar* types; and the lengths of *oval* magnets, finally, from 1½ to ¾ the diameter of the equivalent circular area for *bipolar* types, and from 1¼ to ⅝ the equivalent diameter for *multipolar* types.

In the following Tables LXIV., LXV., LXVI., LXVII., the dimensions of *cylindrical* magnet cores for *bipolar* types, of *cylindrical* magnet cores for *multipolar* types, of *rectangular* magnet cores, and of *oval* magnet cores, respectively, have been calculated. In the former two of these tables the lengths and corresponding ratios are given for *cast iron* as well as for *wrought iron* and *cast steel* cores, in the latter two for *wrought iron* and *cast steel* only. From Tables LXIV. and LXV. it follows that *cast iron* cores are made from 20 to 10 per cent. longer, according to the size, than *wrought iron* or *cast steel* ones of the same diameter, the lengths of cast iron cores of rectangular or oval cross section can therefore be easily deduced from the figures given in Tables LXVI. and LXVII.

(To be continued.)

TABLE LXIV.—DIMENSIONS OF CYLINDRICAL MAGNET CORES FOR BIPOLAR TYPES.

Total flux in webers.	Dimensions of magnet cores in inches.					
	Wrought iron and cast steel.			Cast iron.		
	Diam. *dm*	Length. *lm*	Ratio. *lm : dm*	Diam. *dm*	Length. *lm*	Ratio. *lm : dm*
70,000	1	3	3.0	1½	4½	3.0
150,000	1½	3¾	2.5	2¼	5¾	2.56
275,000	2	4½	2.25	3	7	2.33
425,000	2½	5	2.0	3¾	8¼	2.20
600,000	3	5¾	1.92	4½	9½	2.11
850,000	3½	6½	1.86	5¼	10¾	2.05
1,100,000	4	7½	1.87	6	12	2.0
1,700,000	5	9	1.80	7½	14¼	1.9
2,500,000	6	10½	1.75	9	16½	1.83
3,360,000	7	12	1.72	10½	18	1.71
4,500,000	8	13½	1.70	12	20	1.67
5,500,000	9	15	1.67	13½	22	1.63
7,000,000	10	16	1.60	15	24	1.60
8,500,000	11	17	1.55	16½	25½	1.55
10.000,000	12	18	1.50	18	27	1.50
15.000.000	15	22	1.46	22½	32	1.42
22,500,000	18	25	1.39	27	37	1.37
30,000,000	21	28	1.33	31½	41	1.30
40,000,000	24	31	1.29	36	45	1.25
50,000,000	27	34	1.26	....	....	....
60,000,000	30	36	1.20	....	....	....
75,000,000	33	38	1.15	....	....	....
90,000 000	36	40	1 11	....	....	....

TABLE LXV.—DIMENSIONS OF CYLINDRICAL MAGNET CORES FOR MULTIPOLAR TYPES.

Total flux per magnetic circuit in webers.	Dimensions of magnet cores in inches.					
	Wrought iron and cast steel.			Cast iron.		
	Diam. *dm*	Length. *lm*	Ratio. *lm : dm*	Diam. *dm*	Length. *lm*	Ratio. *lm : dm*
275.000	2	2	1.00	3	3½	1.17
600,000	3	2¾	.92	4½	4½	1.00
1,100,000	4	3½	.875	6	5½	.92
1,700,000	5	4	.80	7½	6¾	.90
2,500,000	6	4½	.75	9	8	.89
4,500,000	8	6	.75	12	10½	.875
7,000,000	10	7½	.75	15	13	.87
10.000.000	12	9	.75	18	15	.83
15,000,000	15	11	.73	22½	18	.80
22.500,000	18	13	.72	27	20	.74
30.000,000	21	14½	.69	31½	22	.70
40,000.000	24	16	.67	36	24	.67
50,000,000	27	17	.63	....	....	....
60,000.000	30	18	.60	....	....	....
75,000,000	33	19	.58	....	....	....
90,000,000	36	20	.56	....	....	....

TABLE LXVI.—DIMENSIONS OF RECTANGULAR MAGNET CORES. (WROUGHT IRON AND CAST STEEL.)

Total flux per circuit. Webers.	Cross section.				Length.			
	Breadth, inches.	Width, inches.	Area, square inches.	Diam. of equiv. circular area *dm.*	Bipolar types.		Multipolar types	
					Length *lm.*	Ratio *lm : dm.*	Length *lm.*	Ratio *lm : dm.*
500,000	2	3	6	2¾	4½	1.64	3½	1.27
700,000	2	4	8	3⅛	5	1.57	4	1 25
1,000,000	2	6	12	3 15/16	5½	1.40	4⅓	1.14
1,400.000	2	8	16	4½	6	1.33	5	1.11
1.200,000	3	4½	13.5	4⅛	5½	1 31	4⅓	1 08
1,600,000	3	6	18	4 11/16	6¼	1.30	5	1.04
2,400 000	3	9	27	5⅞	7½	1.28	6	1.02
3,200,000	3	12	36	6¾	8½	1.26	6½	.96
2,000.000	4	6	24	5⅛	7	1.26	5¾	1.03
2,750,000	4	8	32	6 3/16	8	1.26	6¼	.98
4,250,000	4	12	48	7⅞	9¾	1.24	7½	.95
5,500.000	4	16	64	9	10¾	1.20	8½	.95
4.750,000	6	9	54	8 3/16	10	1.20	8	.96
6,500,000	6	12	72	9⅜	11½	1.20	9	.94
9,500,000	6	18	108	11¾	13½	1.15	11	.94
12,500,000	6	24	144	13½	15½	1.15	12⅛	.93
8,500.000	8	12	96	11	13	1.18	10½	.96
11,000,000	8	16	128	12¼	15	1.18	12	.94
17,000,000	8	24	192	15⅝	17½	1.12	14	.90
13,000,000	10	15	150	13⅞	16	1.15	12½	.90
17,500,000	10	20	200	16	18	1.12	14	.875
26,000,000	10	30	300	19½	20	1.03	16	.82
19,000,000	12	18	216	16⅝	18	1 08	15	.90
25.000,000	12	24	288	19⅛	20	1 05	16	.84
38,000,000	12	36	432	23½	22	.94	18	.77
30,000,000	15	22½	337 5	20¾	20	.96	17	.82
40.000,000	15	30	450	24	22	.92	18	.75
50,000,000	15	37½	562.5	26¼	24	.90	19	.71
38,000,000	18	24	432	23½	22	.94	18	.765
47,500,000	18	30	540	26¼	24	.915	19	.74
57,000,000	18	36	648	28¾	25	.87	20	.70
55.000,000	21	30	630	28⅜	25	.85	20	.71
66,000,000	21	36	756	31	26	.83	21	.68
77.000,000	21	42	882	33½	27	.81	22	.66
75,000,000	24	36	864	33⅛	27	.81	22	.66
90.000 000	24	42	1008	35⅞	28	.80	23	.66
100,000,000	24	48	1152	38¼	30	.785	24	.64

TABLE LXVII.—DIMENSIONS OF OVAL MAGNET CORES. (WROUGHT IRON AND CAST STEEL.)

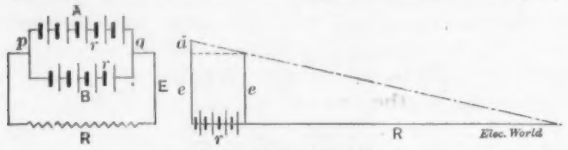
Total flux per circuit. webers.	Cross section.				Length.			
	Breadth, inches.	Width, inches.	Area, square inches.	Diam. of equiv. circular area *dm.*	Bipolar types.		Multipolar types	
					Length *lm* inches.	Ratio *lm: dm.*	Length *lm* inches.	Ratio $l_m : d_m$.
600,000	2	4	7 14	3	4½	1.50	3⅜	1.17
1.000,000	2	6	11.14	3¼	5¼	1.40	4¼	1.13
1,300,000	2	8	15.14	4⅜	6	1.37	5	1.14
1.400,000	3	6	16.06	4⅜	6	1 33	5	1.11
2,200.000	3	9	25.06	5⅝	7½	1.33	6	1 07
3,000.000	3	12	34 06	6⅝	8½	1.28	7	1.05
2,500,000	4	8	28.56	6	7¾	1.29	6	1.00
3,900,000	4	12	44.56	7½	9¾	1 27	7½	1.00
5.250,000	4	16	60.56	8¾	11	1.26	8½	.97
5,500,000	6	12	64.26	9	11	1.22	8½	.945
8,750,000	6	18	100.26	11¼	13	1.16	10½	.93
12,000,000	6	24	136.26	13⅛	15	1.14	12	.915
10,000.000	8	16	114 14	12	14	1.17	11	.92
15,000,000	8	24	178 14	15	16	1 065	13	.87
15.000,000	10	20	178.5	15	16	1.065	13	.87
24,000,000	10	30	278.5	18¾	20	1.065	16	.85
22,500.000	12	24	257	18	18	1 00	15	.835
35,000.000	12	36	401	22½	21	.93	17	.755
35,000,000	15	30	400	22½	21	.93	17	.755
55.000.000	15	45	625	28¾	25	.885	20	.71
50,000,000	18	36	578	27½	24	.885	19	.70
60.000.000	18	42	686	29½	25	.85	20	.68
70,000,000	21	42	787.	31⅝	26	.82	21	.66
80,000,000	21	48	913	34⅛	27	.79	22	.645
90.000,000	24	48	1028	36⅛	28	.78	22½	.625
100,000,000	24	54	1172	38⅝	30	.78	24	.62

Electrodynamic Machinery—XXVII.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

134. From the preceding considerations it is evident that while it is possible to design a bipolar generator for any desired output, yet, in practice, simple bipolar generators are not employed for outputs exceeding 250 kw, and, in fact, are seldom employed for more than 100 kw, since their dimensions become unwieldy and their output, per pound of weight, smaller than is capable of being obtained from a well designed multipolar machine.

In the same way a quadripolar generator can be made to possess any desired capacity; but, in the United States, practice usually increases the number of the poles with an increase in the output of the machine. Thus, it is usual to employ a four



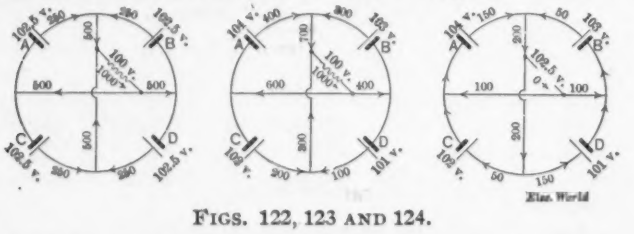
FIGS. 120 AND 121.

pole or six pole generator for outputs of from 25 to 75 kw, and 12 poles for a generator of 400 kw capacity.

135. Should the armature of a multipolar generator not be concentric with the polar bore, *i. e.*, if it is nearer one particular pole than any of the others, the reduction in the length of the air gap opposite such pole, will reduce the reluctance of that particular magnetic circuit, and by reason of the increased flux through the armature at this point induce a higher E.M.F. in the segments of the armature adjacent to the pole than in the remaining segments. If the armature be not interconnected; *i. e.*, if it employs as many pairs of brushes as there are poles, these unduly powerful E.M.Fs. can send no current through the armature as long as the brushes remain out of contact with the conductors, for an inspection of Figs. 114 and 115 will show that no abnormal increase of E.M.F. can exist in a single segment, but must be simultaneously generated in adjacent segments, and that such pairs of E.M.Fs. will counterbalance each other. When, however, the brushes are brought into contact with the armature conductors, thereby bringing the various segments into multiple connection with one another, a tendency will exist for the more powerful E.M.F. to reverse the direction of current through the weaker segments.

136. Whether this tendency will result in an actual reversal of current depends upon the difference of E.M.F. between the segments, their resistance, and the external resistance or load.

Let A and B, Fig. 120, represent the E.M.Fs. of any two segments in a multiple-connected Gramme-ring armature and let the E.M.F., E, of A be greater than the E.M.F., E', of B. Owing to drop of pressure in the internal resistance r, the pressure e, at the terminals p, q, will be less than the E.M.F., E, of the stronger segment A. If e is greater than E', a current of strength $\frac{e-E'}{r}$ will pass through the segment B, in the direction opposite to that in which its E.M.F. acts. If e be equal to E' there will be no current throught the segment B, while if e be less than E' a current will be sent through B in the direc-



FIGS. 122, 123 AND 124.

tion in which its E.M.F. acts, but of strength less than that supplied by segment A. Thus, in Fig. 121 the E.M.F. E of the stronger segment A, is represented by the ordinate $e+d$. Owing to the resistance r, in the segment A, a drop of pressure d will take place within it, and the pressure at its terminals will be e volts. If E' be less than e, the stronger segment A will send a current back through the segment B, while if E' be greater than e, both segments will contribute current through the external load resistance R ohms.

For example, a separately excited quadripolar generator of say 100 kw capacity, supplying 1,000 amperes at 100 volts terminal pressure, has a resistance in each of its four armature segments A, B, C, D, of $\frac{1}{100}$ ohm; then, provided its four magnetic circuits are balanced or equal, the full load on each segment will be 250 amperes, and the drop in each 2.5 volts; so that the four E.M.Fs. will be, Fig. 122:

		E. M. F.	Drop. Volts.	Current. Amperes.	Power. Watts.
A	=	102.5	2.5	250	625
B	=	102.5	2.5	250	625
C	=	102.5	2.5	250	625
D	=	102.5	2.5	250	625
				1,000	2,500

The power expended in each segment of the armature by the current as I^2R, will be $\frac{250 \times 250}{100} = 625$ watts, and the total I^2R loss in the armature, 2,500 watts.

137. Considering one of the segments, say C, as normal, and that A, owing to magnetic dissymmetry, gives an E.M.F. two volts in excess; B, one volt in excess; and D, one volt in deficit; the excitation necessary for 1,000 amperes total output will produce (Fig. 123) the following conditions; namely:

		E. M. F. Volts.	Drop Volts.	Load. Amperes.	Power. Watts.
A	=	104	4	400	1,600
B	=	103	3	300	900
C	=	102	2	200	400
D	=	101	1	100	100
				1,000	3,000

138. The effect of magnetic dissymmetry in the segments under the assumed difference of three volts, will produce, at full load, a difference of output among the segments, ranging from 100 to 400 amperes, while the total power wasted in the armature winding will be increased 20 per cent.; namely, from 2,500 to 3,000 watts. The armature will, therefore, be raised to a higher temperature, owing to the magnetic dissymmetry, but this increase in temperature will not be localized, since, although at one moment a greater amount of heat is being produced in certain segments than in others, yet, owing to the rotation of the armature, the portions of the armature constituting these segments is constantly changing.

139. Suppose now the external circuit be entirely removed, the brushes remaining in contact with the conductors (Fig. 124), so that the circuits through the armature segments are complete, then the following conditions will hold:

		E. M. F. Volts.	Drop. Volts.	Current. Amperes.	Power. Watts.
A	=	104	1.5	150	225
B	=	103	0.5	50	25
C	=	102	—0.5	— 50	25
D	=	101	—1.5	—150	225
				0	500

An inspection of these values shows that a difference of three volts between the E.M.Fs. of the four segments, produces a reversal of current through C and D, at no load, with a useless expenditure of 500 watts. Consequently, between no load and full load, there will be a change from an expenditure of power with reversal of current in the weaker segments, to an excessive drop and expenditure of power without reversal of current.

140. Although this difficulty, arising from the unbalanced magnetic position of the armature, does not, in practice, give rise to any serious inconvenience, when mechanical construction is carefully attended to, yet windings have been devised by which it may be altogether avoided. For example, if all the turns be so connected that their E.M.Fs. are placed in series, then a single pair of brushes will be capable of carrying the current from the entire armature which will only be divided into two circuits; or, the segments may be so interconnected that turns in distant segments may be connected in series so as to obtain a more general average in the total E.M.F. Such windings are always more or less complex, and the reader is referred to special treatises on this subject for fuller details.

The formula for determining the E.M.F. of a multipolar Gramme generator armature is,

$E = \Phi n w$ C.G.S. units, where Φ is the useful flux in webers, or the flux entering the armature through each pole, n the number of revolutions per second of the armature, and w the number of turns on the surface of the armature counted once around. If, however, the armature be series connected, so that instead of having p circuits through it between the brushes, where p is the number of poles, there are only two circuits, then the E.M.F. will be $E = \frac{p}{2}\Phi n w$, while if, as in some alternators, the circuit between the brushes be a single one, the E.M.F. of the armature will be $p\Phi n w$.

142. Fig. 125 represents the magnetic circuits of an octopolar generator, the dimensions being marked in inches and in centimetres. The field frame is of cast steel, and the armature core is formed of soft iron discs. Let us assume that there are 768 turns of conductor in the armature winding, and that the speed of rotation is 172 revolutions per minute, or 2.867 per second.

Assuming an intensity of 9,500 gausses in the armature, it may be required to determine the E.M.F. of the machine.

The cross section of the armature is $31.1 \times 13 = 404.3$ sq. cms., but allowing a reduction factor of 0.92 for the insulating material between the discs, the cross section of iron is 372 square centimetres. The total flux passing through the cross section of the armature will, therefore, be $372 \times 9{,}500 = 3{,}534{,}000$ webers.

The useful flux through each pole will be twice this amount, or 7,068,000 webers, so that the E.M.F. of the generator will be:

$E = \Phi nw = 7{,}068{,}000 \times 2.867 \times 768 = 1.557 \times 10^{10} = 155.7$ volts.

This will be the E.M.F. of the generator, provided all the armature segments are connected in parallel as shown in Fig. 115. If, however, the armature winding be so connected that only a single pair of brushes and a single pair of circuits exists through the armature, the E.M.F. would be 4 times as great, while if the armature could be connected in a single series, the E.M.F. would be 8 times as great.

In order to determine the M M.F. necessary to drive this flux through the armature we proceed as follows:

We first determine the cross section, the mean length, and the intensity in each portion of the magnetic circuits. One of the eight magnetic circuits through the armature is represented by

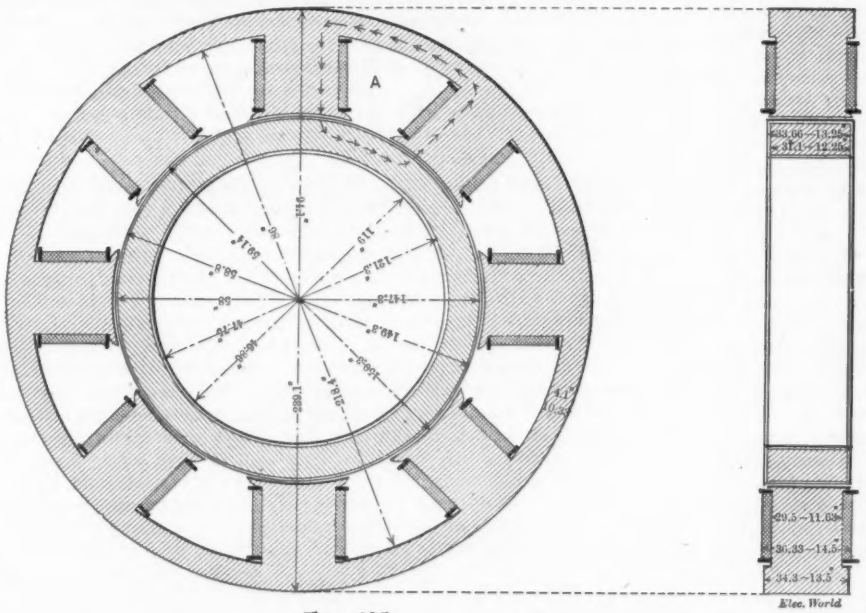


FIG. 125.

the dotted arrows at A (Fig. 125). We may assume that the flux through the cores is $7{,}068{,}000 \times 1.3 = 9{,}188{,}400$ webers; 1.3, being the approximate leakage for a machine of this type; in other words, of all the flux passing through the cores $\frac{10}{13} \times 100 = 76.9$ per cent. approximately may be assumed to pass through the armature, half through each cross section.

	Cross section. Sq. cms.	Flux. Webers.	Intensity. Gausses.	Length. Cms.
Field core	644	9,188,400	13,430	40
Yoke	354	3,534,000	9,980	76
Armature	254	3,534,000	9,500	50

The entrefer, or gap of copper, air and insulation, existing between the iron in the armature and in the pole faces, is 1.5 centimetres in length, while the polar area is 41 centimetres × 34 cms. wide, equals 1,400 square centimetres in cross section. From these the reluctance in the magnetic circuit through the armature is

	Length. Cms.		Reluctivity.	Cross section.	Cross section carrying armature flux.	Reluctance. Oersteds.
Field core	40	13,430	0.002	342	263.1	0.000,304
" "	40	13,430	0.002	342	263.1	0.000,304
Yoke	76	9,980	0.001	254	354.0	0.000,215
Entrefer	1.5		1.	700		0 002,142
"	1.5		1.	700		0.002,142
Armature	50	9,500	0.0008	372	372	0.000,107,5
						0.005,214,5

The M. M. F. required to drive a total flux of 3,534,000 webers through this circuit will be

$3{,}534{,}000 \times 0.005{,}214.5 = 18{,}430$ gilberts.
$= 14{,}665$ ampere turns.
$= 7{,}333$ ampere turns on each spool.

With 600 turns on each spool, the current would be 12.22 amperes.

Laboratory of Houston and Kennelly, Philadelphia.

(To be continued.)

Electrical Difference of Potential.

To the Editor of The Electrical World:

SIR:—Having taken considerable interest in the discussion conducted in your columns concerning the electrical difference of potential analogy advanced by Mr. Waddell, I beg leave to present a point in which, if wrong, I shall be glad to be corrected. To my mind the trouble seems to hinge on a rather loose use and possible confounding of the terms "E. M. F." and "difference of potential."

Force in general is that which moves or tends to move matter; and whatever electricity may be, electromotive force is certainly that force which moves or tends to move electricity. Difference of potential, on the other hand, is the result of work done, and is measured in terms of work. In the case of the voltaic cell alluded to by Mr. Waddell, the E. M. F. is that force which causes the travel of the ions and with them their respective charges. The result of the procession of atoms is that the copper is charged positively with respect to the zinc. This difference in charge constitutes a difference of potential and the procession of the charged atoms will continue until the force tending to move them is exactly balanced by the difference in electrical pressure which their motion has created. When this state of affairs is reached, no more work is done until the back pressure (difference of potential) is relieved by connecting the plates and allowing a current to flow. The point is, that while difference of potential is an E. M. F., all E. M. Fs. are not differences of potential.

In the case of a wire moving with uniform velocity in a uniform field, the cutting of the lines of force is (or causes) an E. M. F. and produces a transfer of electricity in the conductors, sufficient in amount to charge the opposite ends of the wire to a potential difference which is exactly equal to the E. M. F. and *opposite in direction*.

This is a condition of equilibrium and no more requires energy to maintain it than it does to hold a stone away from the earth. Mr. Waddell's analogy is defective in that it does require energy to maintain a difference of pressure in the box, due to the air slipping past the paddles, but if instead he substitutes an equal number of closely fitting pistons (frictionless of course) I think the analogy holds in all respects, at least as far as it is possible for a mechanical analogy to represent a phenomenon whose ultimate nature is so little understood. D. R. LOVEJOY.

NEW YORK, N. Y.

Dangers in Kite Flying.

The French journal *Cosmos* records the case of a lad who was flying a kite, and while drawing it in a thunderstorm gathered, the lightning from which traveled down the string burning it and rendering him unconscious; the kite was only about 300 feet high when the accident took place.

Electrical Misinformation.

Referring to the electrical transmission of power from Niagara to Buffalo, an electrical contemporary says editorially: "We think it is safe to say that this transformation of the water power into electricity will not be with an efficiency of more than 85 per cent.; that the *transmission efficiency* will not exceed 75 per cent.; that the *transformation* at Buffalo will not average 75 per cent., and that the *distribution* in Buffalo will not be at greater efficiency than 80 per cent." In the same article it is stated that the transmission loss in the 110-mile Frankfort-Lauffen experiment was "but 25 per cent.," whereas the entire losses—from the generator, step-up transformer, line, step-down transformer and final distribution—were, in fact, between 24.7 and 31.5 per cent., the power transmitted varying from 78.2 to 197.4 hp.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors, or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 922 Chestnut street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French, or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

DYNAMOS, MOTORS AND TRANSFORMERS.

Reversible Regenerative Armatures and Short Air Space Dynamos.—An Institution paper by Mr. Sayers is reprinted in full with the discussion (but unfortunately without the illustrations) in the Lond. "Elec. Eng.," Feb. 15. He describes the development of his commutating device (see Digest, June 10-17, July 1 and Sept. 16, 1893). It was found that it was often a serious drawback that these machines could be run in only one direction, but this difficulty has been solved by the present arrangement, which he describes as follows: "In these figures there are represented two sections of the main winding of a drum armature—a commutator coil, which is connected to the main winding at the junction between the coils mentioned, and a commutator blade. The direction of winding is the same in the two figures, but in the first the direction of rotation is represented as being clockwise, while in the second it is counter-clockwise. A little study of these two diagrams will show that the commutator coil acts in precisely the same way in whichever direction the armature rotates, the brushes being always set with a backward lead, so as to bring the side of the commutator coil which is behind the point of connection to the main winding under the edge of the flux born. In both cases only one side of the commutator coil is operative, the other side being in a position in the interpolar gap where normally there is no effective field." He shows an analogy between the problem of sparkless commutation and the problem of preventing knocking in a high speed engine; the inertia of the reciprocating parts must be overcome by the steam pressure, so the reversal of the current against the self induction must be overcome by internal E. M. Fs. and not by the make and break action at the commutator. Regarding the number of segments in the commutator he states that the necessity formerly found for using a large number ceases to exist in these machines, in which the number is governed by the difference of voltage which it is advisable to allow between adjacent commutator segments. He discusses the design of slotted armatures; the opening at the top of the slot should be as wide as is consistent with the increased production of eddy currents in the field magnet and it should not exceed 1.5 times the air space; the number of conductors should be as small as is consistent with the cost of manufacture. He discusses parallel running, stating that machines for this purpose must not have a rising characteristic; he suggests an arrangement of compound machines which will run in parallel, it is usual, however, in central station work to use shunt machines; with short air space machines considerable generative power is required in the armature in order to get even a moderate fall in the characteristic. He describes a system of rocking brush holders for reversing motors in which the friction of the brushes causes them to be carried around with the armature until brought up to certain stops. In discussing constant speed motors he states that with his arrangement he obtains the lightest weight and minimum cost with the best regulating qualities. He gives a description with data of his 80-kw dynamo. In the discussion Mr. Crompton believes that Mr. Sayers justly claimed to have solved the difficulty of the trouble with commutators in short air space designs. Mr. Anderson states that there is a saving of about 25 per cent. in weight in these machines. Mr. Mordey admired the arrangement but believes there would be sparking. Mr. Parshall referred to some experiments in the same direction stating that a machine of 1,000 and another of 2,000 hp were shown at the World's Fair where they worked well without sparking; he doubts whether the economy in weight, as compared with some recently designed machines, had been demonstrated; the weight of the armatures seems excessive as also the weight of the copper on it. Mr. Esson believes the extra coils add considerably to the cost of the machine.

The Niagara Dynamos.—Prof. Forbes, in a communication to the Lond. "Elec. Rev.," Feb. 22, questions a recent statement that alternators with outside revolving fields have been made before, and he asks for further information, stating that his American patent No. 518,944 would be void if any prior publication exists; he claims that it was only by adopting this type that the requirements of the turbine makers at that plant could be met.

Armature Fault Testing.—A simple and practical method is described by Mr. Brousson in the Lond. "Elec. Rev.," Feb. 22. It is a method for finding a fault in the armature winding without unsoldering the connections to the commutator. A suitable current is passed through the armature from brush to brush, sufficiently large that there is a measurable difference of voltage between the commutator segments; each brush must not make contact with more than one segment at a time; one terminal of a low reading high resistance voltmeter is connected to one brush and the other to the frame of the machine; it is advantageous to be able to alter the resistance in the voltmeter circuit in order to give suitable readings; the armature is turned slowly by hand until that position is reached in which the voltmeter records the smallest deflection, the commutator segments to which the faulty coil is attached will then be under the brush which is connected to the voltmeter; the maximum deflection will be obtained when the faulty coil is under the other brush; to find which of the two coils connected to the segment is the faulty one the voltmeter readings must be carefully noted when the brush touches the segments on each side, the faulty coil is then the one which is connected between the two segments which give the lowest readings. If the insulation is broken down in two distinct parts the deflections on the voltmeter will not increase or decrease regularly as the armature is turned; when two faults are close together there is no difficulty in locating the position, but it is not so simple when they are far apart The insulation resistance can be measured approximately in the usual way by this same method.

Researches with a Rotary Field.—A paper of some length by Mr. Bragstad, describing some researches, is published in the "Elek. Zeit.," Feb. 21; the direction of investigation is the same as in the paper of Dr. Duncan published in THE ELECTRICAL WORLD July 7, but the method used is entirely different, as Duncan's method can be used only when there is current in the armature. He used a two-phase motor of a somewhat old type; the first tests were made with continuous currents with the armature at rest; he measured the distribution of the field over the surface of the armature; a small coil was attached to the armature and connected with a ballistic galvanometer; the results are given by curves. Another set of tests was made with the armature in motion, by the insertion in the air gap of thin fixed wires parallel to the shaft. From these experimental investigations he finds that at no load, currents on which a positive torque is exerted exist almost only between two pole pieces; this torque is largely compensated by an opposite one existing at the point of strongest induction; the accompanying armature currents represent a large loss of energy and produce heat in the armature; when loaded the currents, on account of the slow speed, are quite weak, while the strongest currents are not well utilized on account of the weak magnet induction existing at that place; one should therefore strive to have the strongest current where the perpendicular component of the magnetic induction is the strongest; the efforts made in practice to have a constant field velocity are therefore in the right direction; how far the result is accomplished must be shown by measurements made with modern machines.

Rotating Alternating Field.—In "L'Elettricista," Feb. 15, Mr. Malagoli investigates the properties of an alternating magnetic field which is kept in uniform rotation, so as to perform one revolution in the time of a complete period. He suggests utilizing these properties in an apparatus intended to double or to halve the frequency of an alternating current. By superimposing a rotating alternating field and a Ferraris field, he thinks it possible to obtain a steady one.

Core Losses in Transformers.—The paper of Mr. Wilson (see Digest last week) is concluded in the Lond. "Elec.," Feb. 22. He gives the diagrams of the connections in the tests, also tables and curves showing the results of his measurements; tests were made for determining the stray field by means of exploring coils, from which he concludes that as far as one can judge, and with the assumption of uniform distribution of the induction, every element of the core experiences each half period a maximum induction intensity about as great as on open circuit, although at any epoch the linear distribution is not the same on account of the stray magnetic field; the loss observed on full load is less than one might reasonably expect from magnetic hysteresis alone.

LIGHTS AND LIGHTING.

Substitute for a Vacuum.—Mr. Forster, in the Lond. "Elec. Rev.," Feb. 22, suggests that as the new element, "argon," which exists in the atmosphere, is an inert gas, it might be applied with success for filling

the bulbs of incandescent lamps. (Would it not be much more expensive to obtain a bulb full of this gas in its pure state than it would to produce a vacuum, and does it follow that because it is chemically inert it would answer the same purpose as a vacuum in an incandescent lamp, in which not only the chemical but also the physical properties play an important part?)

Small Inside Reflectors for Alternating Arc Lamps.—The question of priority is discussed in a communication from the Helios Company in the Lond. "Elec. Rev.," Feb. 22.

POWER AND HEAT.

Arc Welding.—The paper of Mr. Foster (see Digest last week) is concluded in the Lond. "Elec. Eng.," Feb. 22. He describes the application of arc welding to altering a very large piston and discusses at some length repairs of steam boilers, giving a list of repairs which have been made; in several cases cracks again occurred through the repaired joints but he believes that by slightly increasing the total thickness by building up the metal at this point, the trouble can be entirely overcome. Another important application is in cutting and boring; holes may be pierced in this way with great rapidity and they may be elongated into slits of any required length; an illustration is given of a large wrought iron pipe in which a large number of holes were pierced in this way at the rate of two or three per minute. He describes the plant and apparatus required. Regarding the necessary precautions he states that the carbons should not be copper plated, should be sound and hard, having a metallic ring when struck, and must burn with little or no dust, which would render the metal brittle; when building up the metal, the additional metal should have the same composition and the slag should be removed from each layer before commencing to add another; a ridge of gannister clay should be formed to keep the molten metal in place; the surrounding metals should be well heated with a long and steady arc to insure gradual solidification; whenever possible each layer of new material should be hammered immediately after the carbon is withdrawn, and if this cannot be done the withdrawing should be gradual. Regarding the quality of work done, a number of welds were made by this as also by the usual smith's process and were tested; the "average ratio of weld to solid" of the electric welds was 85.5 per cent. for iron and 80.8 for steel; a comparison of the hand welded bars with those electrically welded will in every case show a higher ratio for the latter; the economy of the system as used in several places is claimed to be established beyond a doubt; it is not proposed as a substitute for all cases of welding nor for riveting, but rather as an additional method capable of extensive application under conditions where the other methods are inapplicable; simplicity and ease of transportation are among the chief advantages; he suggests the use of such a plant on board a small steam craft in a harbor, for making repairs on vessels.

Thawing by Electricity.—Mr. Edmunds, in the Lond. "Elec. Rev.," Feb. 22, recommends the use of electrical heat for thawing gas and water pipes; he describes an arrangement (which seems unnecessarily complicated) which is drawn into the pipe, and which in a recent test worked very well; a complete thawing was effected in four minutes.

Electric Lighting Engines.—Those used in the station in Vienna are well illustrated in large plates in Lond. "Engineering," Feb. 22.

Working Ships' Turrets.—A communication on this subject by Mr. Maxim is published in Lond. "Engineering," Feb. 22.

Long Distance Transmission of Power.—An interview with Dr. Bell, of the General Electric Company, is published in the "St. Ry. Jour." for March. He considers the present outlook for transmission plants most excellent; the principal difficulty concerns the transmission line, its maintenance and guarding against accidents or malicious injury; he considers 5,000 to 15,000 volts within the range of fair practicability if the climatic conditions are favorable; he would not hesitate to make it 30,000 to 50,000 in a climate like that of some parts of Mexico; the limitation for transmission is the maintaining of the line; transmitting cheap water power up to 10 or 15 miles will nearly always pay if the amount is reasonably great, 100 to 1,000 hp; up to 30 miles a fair proportion of the propositions investigated indicated commercial success; from 30 to 50 miles a few, but beyond 50 very few indeed; in one case of 150 miles it would have been a certain commercial success, as the climate was extremely favorable, coal at the receiving end costing $40 a ton in gold; the voltage proposed was 20,000. To his knowledge, the long power transmission plants are four, of about 18 miles each, one at Genoa, Italy, another from Tivoli to Rome, a third into Biberest, Switzerland, and a fourth into Guadalajara, Mexico; they are all of considerable size, involving several hundred horse power; there is a small lighting plant in California operated over a distance of 28 miles; the voltage at San Bernardino is 10,000, and that at the others between 5,000 and 6,000; two of the plants are operated by continuous currents with several generators in series; in the Rome plant the generator gave 5,000 volts directly. There is a serious difficulty in utilizing the current from the Niagara plant in Buffalo on account of the inability to run incandescent lamps without changing to direct current. He believes that a very large part of the power transmitted over long distances will be used in multiphase motors; also that they are displacing continuous currents motors for most purposes, as they are not afflicted with the commutator; he does not believe that they will be used on street railways in cities but certainly in interurban and long distance work; they require at least three wires, but for interurban work the double trolleys would constitute no serious objection; if used for street railway service there will be no more burning out of the armatures; he has never succeeded in burning out the armature of a polyphase motor even in the hardest kind of experimental work, although he sent currents through them until the leads burnt off.

Electric Motors for Driving Machine Tools.—Supplementing the paper of Mr. Richmond, abstracted in the Digest last week, the "Eng. News," Feb. 28, publishes parts of a letter from Mr. Melotte, giving some additional information regarding the Herstal (Belgium) installation. Since the electric motors were installed the shop has been enlarged, and the power plant will soon have a capacity of 5,500 amperes at 125 volts; the reason for this increase is more particularly in the increase of useful work done by the workmen operating the machine tools; at the outset the output was estimated at 150 pieces per workman, but the establishment of the piece-work system so stimulated the workmen that the output was raised to an average of 300 pieces per day; at first 16 hp motors were connected to a shaft, but they were soon found to be developing 30 hp; the shafts were, therefore, cut in the middle and a motor placed at each end; he calls attention to the difficult situation of this gun factory; if instead of this motor transmission it had adopted mechanical transmission, the difficulty of increasing the transmitted power would have been enormous. He favors high speed motors except for very large units of 1,000 hp and over; heavy machine tools which take 1 hp or more can be operated advantageously by separate motors, but small machines should be operated in groups of three or four by small counter shafting driven by a 2-hp motor.

Niagara Falls Power Plant.—"El'ty," March 6, contains a paper by Mr. Perkins on the municipal ownership of the Niagara power distribution for Buffalo; the subject is also discussed editorially. A paper by the same author on lubricating bearing cooling devices in this plant, including an illustration, is published in the "West. El.," March 9.

Electric Annealing of Armor Plate.—The "Elec. Eng.," March 6, contains an article by Prof. Elihu Thomson, in which he describes the Lemp process, by which the Harveyized armor plates are annealed in order to enable them to be drilled and tapped. These plates have a skin of very hard steel, and it is necessary to anneal them in places where they are to be drilled; the most intense oxyhydrogen flames were found ineffective, but the annealing was accomplished very satisfactorily by the electric process, which consists in passing a current between two blocks of copper laid on the surface and forming the ends of a transformer circuit like in the well-known welding process; after the heating, the temperature is slowly lowered by a very gradual diminution of the current, so as to prevent the too rapid cooling by the conduction of the heat to the massive back plate, which would act as a chill; the use of alternating currents favors the concentration of the heating effects, the self induction effect or reactance is least when the current flows through the surface of the plate and any current which branches from the electrodes and enters deeply into the plate has a longer path of greater self-induction. Highly satisfactory results have been obtained by this process at the Cramp shipyard, and he believes that there is no doubt that the apparatus and process will soon become one of the necessary features in a modern establishment for the construction of armored vessels.

Tempering Hair Springs.—A process is briefly described in the "Sibley Jour." for January, which consists in passing a current through the spring, heating it to the requisite color, at which point it is quenched; by prolonged action of the current during the quenching the interior of the wire can be kept soft if desired; the most perfect method of annealing is obtained by allowing a very slowly diminishing current to traverse it.

TRACTION.

Accumulator Traction.—According to the "Elek. Zeit.," Feb. 21, accumulator cars are to start running regularly within a few days on one of the lines in Berlin.

Electric Traction.—A paper by Mr. Dawson, chiefly of local interest, including some data, is published in the Lond. "Elec. Rev.," Feb. 22.

Power Station Test.—The "Eng. News," March 7, reprints at considerable length a first prize thesis by Messrs. Colles and Gallaher, of Stevens Institute of Technology. It contains a description and the results of a very elaborate test made of a railway power station at West Haven, Conn., in which the Westinghouse "Kodak" arrangement is used, and is said to be one of the most recent designs of that company (the station was erected nearly three years ago). The chief object of the test was to show the value of this type of power plant; a brief description of the plant is given, including considerable data; the average number of car miles per day is 2,040, the average number of passengers per day 11,000; the tests were made in May, 1894, and deal largely with the steam power plant. Although the reprint contains a large amount of data, it is stated that the most important of it is given in an appendix which is not reprinted. As an experiment a recording wattmeter was used to measure the whole output of the station; they point out that the output calculated by multiplying the average amperes with the average voltage will generally give a greater quantity than the true one, as the voltage is highest when the current is lowest and the reverse; specimen charts of the recording instruments and voltage diagrams are given. From a long table of data it appears that the station efficiency—that is, the ratio of the electrical to the indicated hp—was 67.11 per cent., and the coal used per electrical hp per hour was 3.068 pounds; in the text they give 3.08 lbs. for an electrical hp delivered on the line during well

loaded hours, but for one or more entire days it was 3.6 lbs. Regarding the leakage on the line, records from 50 to less than 1 ampere were obtained, the larger value being due to cars left standing with the trolleys on the wire and the lamps turned on, but the latter accounts for only 9 amperes. Tests on the line were made, as also an attempt to determine whether bonding made any difference; from the table it appears that the bonding was followed by a loss, but this shows that figures are misleading, which they explain, and conclude that bonding certainly made a difference, as shown by tests made before and after bonding. A table gives the results of tests of current consumption on a motor car. An average of the station test gives the following: Average number of cars (motor and trailer cars reckoned separately) running during test 16.5, number of car miles 1,474, average electrical hp per car 11.6, average amperes per car 18.2, average electrical horse power hours per car mile 1.55, coal used per car mile 4.76 lbs., cost of coal used per electrical horse power hour 0.473 cent, cost of coal per car mile 0.733 cent. The true value of the station efficiency given above is probably between 75 and 80, and that of the line is 89; the total operating expenses including coal, oil, water and pay roll is 1.5318 cents per car mile, or 0.988 cent per electrical horse power hour; from tests made before and after bonding they show that the saving is sufficient to make it pay to bond the rails if the work cost anything less than $14,100 (not including, however, the cost of damage to water and gas pipes by insufficient bonding). The low line efficiency discounts to a great extent the showing of the station, and shows the fallacy of reckoning that element by car miles instead of by electrical horse power hours; they point out that the difference between an active and a lazy engineer is usually of more significance that that between an economical and an uneconomical design of the station. The ground space per horse power of the whole plant was only about five square feet.

Electrical Traction on Steam Roads.—Some further data regarding the electrical branch of the N. Y., N. H. & H. R. R. is given in the "Elec. Eng.," March 6. The line is perfectly level, seven miles long, reasonably straight, and is an exceptionally favorable place for experimenting. The equipment is to be made interchangeable with their standard cars, and will at first consist of six motor cars, each with two motors of 100 hp; they are expected to draw a trailer with ease; they are 50 feet long and are entered from the side; there will be four baggage cars 30 feet long, of which two are fitted with two motors and two with four motors; it is expected to have the line running in May. The same company is contemplating establishing electrical power plants at the terminals of all branch lines which radiate from the trunk lines.

Electrical Power for Cable Roads.—According to a note in "Eng. News," Feb. 28, a Chicago line is about to try the use of electric power for operating street railway cables, and if it is a success all the company's cable lines will run by electrical instead of steam power; how it is to be applied is not explained.

Electric Towing.—The "Eng. News," Feb. 28, gives some data regarding the operating expenses on the Bourgogne Canal in France, where electric power has been used for a year and a half. There is an evident saving in time and money by the use of electricity; for transporting 1,000 tons 11.65 hours and $20.40 were required with steam, while with electricity these figures were 11.01 and $14. The time of service is too short for drawing any definite conclusions, but the owners believe that the new system will be profitable in the end.

Rail Bonding and Its Bearing on Electrolytic Corrosion.—A communication by Mr. Low, forming a discussion of the recent Institute paper by Mr. Farnham, is published in the "St. Ry. Gaz.," March 2. He considers that the problem of electrolytic corrosion and rail bonding must be considered conjointly; he gives the conditions which cause electrolysis, and describes a peculiar case in which the pitting invariably occurred on the inside of the pipe, working outward; he favors the three-wire system; electrolytic corrosion will not occur when the following requirements have been complied with: "No cross bonding at points where the mains show permanently negative potentials. Heavy cross bonding at points where the mains show permanently positive potentials. Rail bonds of absolute permanence and reliability. High conductivity in track return circuit. Greatest possible resistance from tracks and mains at points where the mains show permanently negative potentials. Generators to permanently feed positive to line and negative to track and main. Heavy bonding between the negative side of generators to various proper points of mains not heretofore designated."

Power Stations.—An illustrated description of a new power station in Chicago is given in the "St. Ry. Jour." for March. A long and well-illustrated description of the street railway system of Buffalo is published in the "St. Ry. Jour." for March. A description of the Columbus Central Railway station, with some illustrations, including a diagram of the switchboard connections, are given in the "Elec. Rev." March 6. A well-illustrated description of some length is contained in the "St. Ry. Jour." for March.

Lyons-Oullins Street Railway.—A description of this French road is given in the "St. Ry. Jour." for March; the apparatus for it was built in this country.

Motor Repairs.—The article by Mr. Shepard, giving practical hints, is continued in the "St. Ry. Jour." for March.

Tower Wagon.—Several forms are described and illustrated in the "St. Ry. Jour." for March.

Snow Plow.—A "home built" plow is described and illustrated in the "St. Ry. Jour." for March. The same number describes the snow and wreckage system in the Chicago Railway Company.

Prospects for Cable and Electric Traction in England.—A short article by Mr. McCallum is contained in the "St. Ry. Jour." for March.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Profitable Plants for Small Towns.—A recent paper by Dr. Luhn is reprinted in abstract and discussed editorially very favorably in the "Elek. Zeit.," Feb. 21; he describes a small plant in a small town in which the electric light plant and the water supply plant are combined into one; the result is very favorable, as the economy from the water sold (by meter at about 4c. per m^3.) covers the total cost, and the income, at the rate of about 7.5c. per kw hour for the electrical energy, is therefore clear profit; the population is 3,000 and the engine power is 50 hp; it includes a battery of accumulators capable of supplying 200 lamps for 7 hours; only two men are required for running the plant; during the night there is no attendance, the current being derived from the accumulators; the supply of water is sufficient for all purposes except for a fire during the night in which case the current from the accumulators runs a pump to supply the extra demand; it is claimed that the Helios Company, which installed this plant, deserves the credit for the first practical application of electric power for fire engine purposes.

Cost of Small Plants.—An editorial note in the Lond. "Elec.," Feb. 22, gives the following estimates of the relative costs of a gas and an electric light plant for a small town or village. An average size gas works will cost from $3,000 to $3,500 for every 1,000,000 cb ft. capacity per annum; at 5 cb ft. as equivalent to 12 cp per hour and 60 watts for 16 cp, this amount of gas is equivalent to about 9,000 kw hours; assuming the annual load factor to be 15 per cent. it will require a plant capacity of about 16 8 kw; Mr. Crompton's estimate of $400 to the station and mains per kw for the low pressure system is regarded as being well above the average; this brings the cost to $2,670 for the electrical plant.

Amortization.—In a communication to the "Elek. Zeit.," Feb. 21, Dr. Haas criticises some of the statements of Mr. Prucker in his article abstracted in the Digest Feb. 16.

ELECTRO-PHYSICS AND MAGNETISM.

Electrodes Sensitive to Light.—The Lond. "Elec.," Feb. 22, abstracts briefly from the "Zeit. fuer Phys. Chem." an article by Mr. Luggin describing an electrode which he claims to be much more sensitive than any hitherto used; a plate of platinum is coated with silver bromide and is then duplicated with a similarly coated plate in a solution of bromide of potassium; exposure to diffused daylight gave 0.5 volts; for weak lights the rise is uniform up to a maximum after which it remains constant; the rate is more marked for stronger lights but is then not directly proportional to the light, besides being also lowered by a previous exposure; continuous and alternating lights of the same intensity do not produce the same effects; the plates do not remain constant.

Double Refraction of Electric Rays.—A paper by Mr. Mack from the "Weid. Ann.," Vol. 54, page 342, is translated in the Lond. "Elec.," Feb. 22; with slabs of wood from 25 to 40 cm thick, analogues of all the well known optical experiments were produced with the aid of oscillators, mirrors and spark gaps.

Retardation of Polarization in Dielectrics.—A translation of the recent paper by Mr. Arno (see Digest, Feb. 9) is published in the Lond. "Elec. Rev.," Feb. 22.

Propagation of Magnetization.—A Royal Society paper by Dr. J. Hopkinson and Mr. Wilson on "the production of magnetization of iron as effected by the electric currents in the iron" is abstracted at some length with some of the illustrations in the Lond. "Elec.," Feb. 22, and is to be concluded in the next issue; a brief abstract is given in the Lond. "Elec. Rev." and "Elec. Eng.," the latter publishing also the discussion, which, however, is not of particular interest. The paper deals with the same subject as that abstracted in the Digest, July 14, but the experimental work was carried out with larger apparatus; the object was to investigate the changes occurring at different depths in a solid core of an electromagnet, in terms of the time after reversal has been made; the magnet was made up of different concentric parts each wound with an exploring coil with which the propagation of the magnetization from the outside to the inside was measured; diagrams of the apparatus and connections are given. The general character of the results was quite unexpected; the curves are given but no general conclusions are drawn in the present portion; the length of time that the currents in the cores exist was somewhat surprising; the induction occurs very rapidly near the surface, less rapidly at some depths and slowly at its centre; with certain magnetizing forces it takes 4 minutes before the central core of a magnet 12 in. in diameter, attains a maximum. The application of the results to magnets with cores of other sizes is pointed out and conclusions are to be drawn (presumably in the next portion) as to the appropriateness of general practice in regard to the sizes of wires or plates used in transformers. The whole paper, which contains a very large number of curves, illustrations and tables is published in the "Phil. Trans. of the Royal Soc. of Lond.," Vol. 185, p. 93, and may be obtained under separate cover. The article does not admit of being abstracted; it is doubtless the most complete investigation of the kind which has been published.

Propagation of Magnetism.—"L'Elettricista," Feb. 15, contains a paper by Prof. Aseoli in which the author points out the analogies between the propagation of magnetism in magnetic circuits and the propagation of heat according to Fourier's theory. He explains the exponential law for the magnetization of an iron bar, as experimentally verified by Prof. Pisati.

Slow Changes in the Permeability of Iron.—The Lond. "Elec." and "Elec. Rev.," Feb. 22, reprint the first part of a Royal Society paper by Mr. Mordey. The conclusions of this paper were given in the Digest, Jan. 12; the present reprint contains the tables, curves and the illustrations of the apparatus. The phenomenon discussed is the gradual increase in the energy absorbed in producing a given magnetization, when iron is magnetized for a long time by rapidly alternating currents; the paper is an account of a careful investigation of the subject.

Magnetic Circuits.—In "L'Elettricista," Feb. 15, Mr. Giorgi begins a series of articles on the applications of the theory of magnetic circuits. In this issue he shows how this method may be applied to a vigorous treatment of some of the scientific problems.

Influence of Temperature on the Pull of Permanent Magnets.—Results of some tests by Mr. Pictet from a recent Academy paper are printed in "L'Elec.," Feb. 23. The magnet weighed about 500 grams; the figures are given for every 5°; for + 30 the attractive force in grams was 61.04 for — 50 it was 68.15 and for — 100 it was 75.8.

Magnetization Curves.—A long article in Lond. "Engineering," Feb. 22, on the Hadfield Steel Foundry contains a series of curves of different qualities of magnet iron and steel made by that company.

Self-Induction in Iron Wires.—A paper by Mr. Klemencic from the "Weid. Ann.," Vol. 53, page 1,053, is reprinted in abstract in the "Elek. Zeit.," Feb. 21. In straight wires of magnetic metal it is not the length and thickness but the magnetic permeability which is the chief factor; he gives the results obtained with three wires each 1 m long and 2 mm in diameter giving the values of the E. M. F. induced in the iron, which it was found increases more rapidly than the current especially for a soft iron and least for Bessemer steel; in comparison with non-magnetic metals the values are 5.2 times as great; with very strong currents such a wire of soft iron may have a self-induction coefficient of more than 1 km. He also examined the axial magnetization and finds that the permeabilities in circular and axial directions are different from each other; with soft iron the circular is smaller than the axial but with hard iron and steel it is the reverse.

The Animal as a Machine.—An editorial in the "Sibley Jour." for January refers to this subject, stating that it has been proved that the efficiency of the vital machine is higher than that of any known artificial motor, and that "it is coming to be believed that the machine is chemico-electro-dynamic."

ELECTRO-CHEMISTRY AND BATTERIES.

Borchers' Battery.—The leading editorial in the Lond. "Elec.," Feb. 22, gives a general review of the discussion of this cell, referring also to Dr. Borchers' reply to the critics, which will be found reprinted elsewhere in the present issue. The editorial states that this reply disposes of all the criticisms on the ground of want of identity of the conditions. In summing up the matter it states that it has been shown that unless exceptional care be taken it is extremely easy to mistake the E. M. F. yielded by the attack of the copper electrode for that produced by the oxidation of the gas, but with one exception the critics have failed to demonstrate that Borchers fell into this error; the statement of Messrs. Barnes & Veesenmeyer (see Digest, Feb. 23), if not refuted, is absolutely fatal to Borchers' claims, this statement is, that an identical cell produced no product of carbon dioxide; Dr. Borchers must disprove this or his cell is discredited. A record of the current and voltage is not sufficient, as a "complete chemical balance sheet must be made out." The same journal publishes a communication from Mr. Barnes criticising the reply of Borchers; he claims that one of the reactions will take place only with ammonia in abundance and the final product will then be a carbonating of ammonia and not carbon dioxide, which is a most vital difference; although theoretically no copper is consumed, yet the copper plates will be attacked by the cuprous chloride formed in other ways. He believes that Dr. Borchers' reply contradicts his former statements and he now admits that it must be left to future experiments to decide if elements can be constructed in which the copper is not attacked, whereas four months ago he laid great stress on the fact that no noticeable decrease in weight was ever observed.

Headland Grid.—An illustration of this plate is given in the Lond. "Elec.," Feb. 22. The plates are composed of rows of rectangular "gridded" tubes containing the active material; a positive weighing 5 pounds may be discharged at the rate of 25 amperes and then has a capacity of 50 ampere hours, the grid forming considerably over one-half of the weight.

Accumulators with Powdered Lead.—Some illustrations and data concerning these accumulators, as made in France, are published in "L'Elec.,' Feb. 23.

Cyanide Gold Extraction.—The report of a recent litigation is published in the Lond. "Elec. Rev.," Feb. 22.

A description of the usual process, taken from a recent paper by Messrs. Butters and Smart, is published in the Lond. "Elec. Eng.," Feb. 22.

Present State of the Electrochemical Industry.—A paper of some length by Mr. Lucieno is published in the "Bul. Soc. Belge. d'Elec.," September, a reprint of which is begun in "L'Elec., Feb. 9. He discusses the industries in which electricity has been applied with success, those for which it has been proposed and those for which its application is possible; existing plants are referred to and in many cases the figures are given; it is probably one of the best summaries of the kind recently published. In conclusion he gives an alphabetical list of chemicals with references where the description of the electric process may be found.

Electro Chemistry.—A recent paper of Mr. Ostwald giving some practical hints, which was abstracted in the Digest, July 21, is reviewed briefly in an editorial in the Lond. "Elec. Rev.," Feb. 22.

Electrical Bleaching of Textile Fabrics.—A lecture by Mr. Matos, delivered before the Franklin Institute, is reprinted in the journal of that Institute for March. He reviewed the entire field of textile bleaching by the ordinary methods, and details the electrolytic processes which have been advanced from time to time. The chief objection to the common process of bleaching vegetable fibres is that the strength of the material bleached is considerably impaired, owing to the formation of oxy-cellulose, and also to the fact that after bleaching has been even successfully accomplished, the fibre or yarns may be quite harsh to the touch, caused by the formation of insoluble salts of calcium, which are almost impossible to remove from the fibres by washing, and which, of course, cannot be removed by chemical means without injury. Cotton is the easiest fibre to bleach; linen, jute, etc., require very great care and attention on the part of the operator. Electric bleaching, so far as it may be called "electric," depends on the electrolysis of a solution of some soluble chloride, like magnesic, sodic, or aluminic. This solution is pumped through an electrolyzer with zinc and platinum electrodes; the electrolyzed solution passes from the electrolyzer on to a single, or series of bleach vats, wherein the final operation is conducted, which may require varying lengths of time, depending upon the strength of solution (usually a 5 per cent. solution of the salt), the kind of bleach desired and the quality of material acted upon; as a general rule, the time required is much less than is required for a chloride of lime bleach. Wool or animal fibres, including silk, have not yet been bleached by means of electrolyzed solutions, owing to the peculiar "yellowing" action of compounds of chlorine on them. The bleaching of paper pulp is carried out now on a large scale, and the results are better than those obtained by the lime method. Pulp digested in either the caustic soda or the sulphite processes, is bleached with equal facility. The principle is the same as employed for fibres and yarns, but certain changes are required in the plant, so as to facilitate the progress of the pulp from one stage to another without loss. Provision must also be made to save the impoverished bleach liquid, which is replenished by adding fresh quantities of the salt. One chief advantage of the electrolytic process over others is that the material bleached only requires a good rinse or wash, and it is finished; no treatment with acid is required. The lecture was illustrated with a series of photographs of machines in actual use.

Accumulator.—A correction of a formula in the recent article describing the Schafer-Heinemann accumulator (see Digest, March 2) is given in the "Eng. & Min. Jour.," March 2.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Accurate Measurements of Strong Currents.—A method devised by Dr. Sahulka is described in the "Elek. Zeit.," Feb. 21; it appears that this method is to be used in the government testing bureau in Vienna. The only method which can be claimed to be accurate is the one using the electrodynamic balances, but for wide ranges this would require a large number of balances; in the new method two such balances will suffice up to say 100 amperes; two circuits are required, in one of which the current is kept at 1 ampere by means of the usual electrodynamic balance; in this circuit there is connected the fixed coil of a second balance whose movable coil is in a shunt circuit to a resistance through which the main current flows; this resistance is made of sheets of manganin; the drop in voltage in this circuit can be so adjusted that it is about 2 volts by altering the resistances, and the current through that coil will therefore always be constant; an accuracy of 1-10 of one per cent. is easily obtained by this method and the apparatus is always used at its greatest sensitiveness. For alternating currents he suggests a similar method in which the shunt to the manganin resistance forms the primary circuit of an ironless transformer having a ratio of 1 to 7, the secondary of which gives the current which is led into the movable coil; the ohmic resistance of the primary coil is small as compared with its apparent resistance, so as to simplify calculations.

Alternating Current Curves.—Dr. Fleming's paper (see Digest last week) is continued in the Lond "Elec.," Feb. 22, in which he gives some reproductions of the curves, among which are several for a Mordey alternator and others of a Thomson-Houston, with and without a load. A curious point about these curves is that while there is a lag of 50 per cent. of the current behind the voltage, for the zero values, there is no lag at all for the maximum values. He claims to have established without a doubt that a water resistance constitutes a perfectly non-inductive load for an alternator; the time for taking a curve with this apparatus requires two to three hours or more "according to luck" but he believes it can be reduced to 10 or 15 minutes and that the process may ultimately become quite as easy as that of taking an indicator diagram.

Photographic Registration for Magnetometers and Galvanometers.—The "Elek. Zeit.," Feb. 21, abstracts a paper by Messrs. Schering and Zeissig from the "Weid. Ann.," Vol. 54, page 1,039, in which they describe an apparatus for recording the deflections in observations made with mag-

netometers and galvanometers; in some of these it is necessary to record the time in seconds. Four metres from the mirror there is an illuminated scale the image of which is reflected into a photographic camera; below this there is another scale the image of which is also reflected in the camera by a fixed mirror; to record the time there is a clock with dials instead of hands, the image of part of which is also reflected in the camera by the fixed mirror; the incandescent light for illuminating the scales is automatically lit every 10 seconds for 1 second.

Alternating Current Curves.—Dr. Fleming's article, mentioned in the Digest last week, is given in abstract with an illustration of the apparatus and a sample curve, in the "Elec. Eng.," March 6.

Electric Gauge.—A convenient form is described by Prof. Ryan and Mr. Macomber, in the "Sibley Jour." for January. It is in the form and appearance of a watch, and answers well for measuring currents of not less than 20 amperes, and of pressures less than 125 volts; the readings can be depended upon within 3 per cent.; a calibration of the readings is given.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Protection Against Strong Currents.—In the "Elek. Zeit.," Feb. 21, Mr. Sesemann discusses the subject of the protection of telegraph and telephone apparatus against lightning and strong currents and describes and illustrates an apparatus which he devised, based on a long experience with such circuits; it consists essentially of a fuse wire in a glass tube mounted conveniently for inspection; with every four circuits there is another fuse in the earthing wire; German silver wire of 0.08 mm melts with about 1 ampere; the fuse for the earth wire may be made to fuse at 10 amperes; in his experience he has found that when coils suffer from atmospheric discharges the injury is usually due to a spark and not to overheating, but he cites two cases in which wires of 0.5 mm and 1.5 mm were melted by atmospheric discharges.

Automatic Telephone Switchboard.—A recent paper by Mr. Mueller is abstracted in the "Elek. Zeit.," Feb. 21. He points out briefly some of the advantages of the Nissl apparatus (see Digest June 2, Sept. 1).

Signal Repeaters.—The Grimes system used on English railways is described briefly and illustrated in the "Elek. Zeit.," Feb. 21.

Pacific Cable.—A letter from the Lond. "Times" referring to a recent communication by Mr. Sandford Fleming is reprinted in the Lond. "Elec. Eng.," Feb. 22.

Telegraphic Exhibition.—A telegraphic exhibition was held in Rome, on Feb. 3, for the benefit of the Sicilian towns damaged by the recent earthquake. The Italian Government exhibited an interesting collection of historical telegraphic appliances, from the Chappe telegraph to the most recent systems.

MISCELLANEOUS.

Educational.—A communication by Prof. Gerard of Liege on the education of electrical engineers is contained in the Lond. "Elec.," Feb. 15. He describes the method used by himself, advocates the construction of instruments by the students and the careful carrying out of a few experiments rather than many carried out less carefully.

Biographical.—A portrait and biographical sketch of Royal E. House, by Mr. Pope, is published in the "Elec. Eng.," March 6. Some reminiscences of Mr. Eickemeyer are given in the "Elec. Eng.," March 6.

New Book.

Elementary Lessons in Electricity and Magnetism. By Silvanus P. Thompson. D.Sc., B.A., F.R.S., F.R.A.S. New edition, revised throughout with additions. New York: Macmillan & Co. 625 pages, 297 illustrations. Price, $1.40.

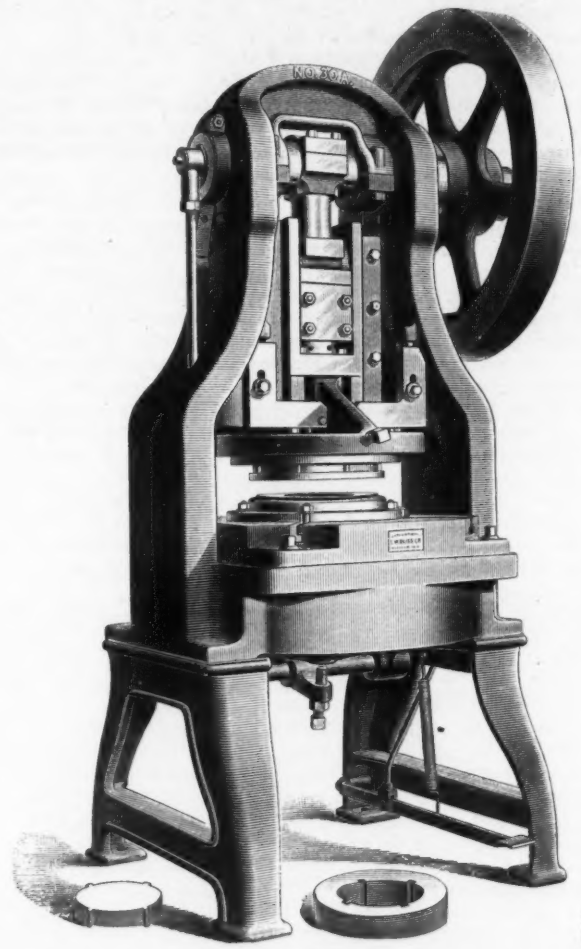
This is a new edition of a work issued in 1881, and it has been largely increased by numerous insertions necessitated by the progress of science in thirteen years, during which an international system of electric units has been adopted and the researches of Ewing, Hopkinson and others have advanced the science of magnetism; electric transmission and transformation have forced the study of alternating currents as applied to motors, transformers and telephones; storage batteries have become of great commercial importance, electric lamps are made in millions, currents for lighting and power are supplied from central stations, and meters and measuring instruments have come into the market. Along with these advances in practice we have the theories of Faraday as developed by Clerk Maxwell, more generally understood, thanks to the labors of Heaviside, Lodge, Heitz, Poincaré and others. And yet many are slow to give up the idea that the copper wire is the medium for transmitting electric energy, and credit this property to the dielectric surrounding the wire.

One would think that this great progress and advance of ideas would necessitate an entirely different presentation of the subject of these lessons from that in 1881. Instead of writing a new book, however, the author has incorporated in the old one a number of modern illustrations and descriptions of apparatus, together with new units and some statements of recent discoveries and modern views. Consequently the whole is patchy. If one had the time and the capacity for logical arrangement he could no doubt find sufficient data in this book for producing a series of rather popular and instructive lessons in electricity and magnetism. As it is, however, the work is perhaps the best in the English language for starting into the study of electrical science.

New Armature Disc Stamping Presses.

The requirements of armature work for electric motors and dynamos have led to the construction of presses which differ in essential points from those used for other styles of sheet metal work.

The accompanying engraving illustrates one of two presses which have been designed by The E.W. Bliss Company, Brooklyn, N. Y., especially for this class of work. In both the presses the "throw out pads," usually controlled by heavy springs, are operated in an absolutely positive manner and consume a very small fraction of the power of the press.



Stamping Press.

It will be seen that, in addition to the usual slide carrying the punch, there is a bottom slide, actuated by an outside crank connection, which operates the dies and "throw out pads" through the radial slots in the bolster. Two cross pieces adjustably attached to the frame of the press actuate the "throw out pads" of the punches by striking against them on the return motion of the main slide.

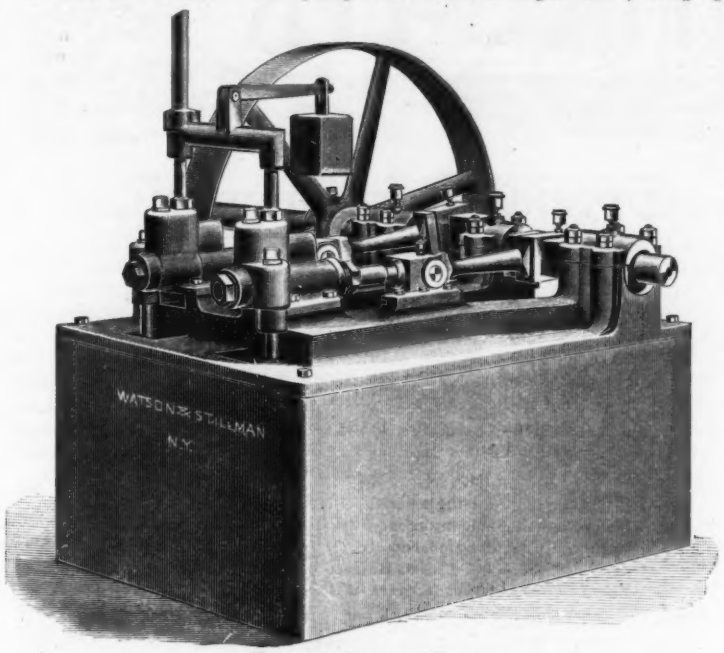
The press shown is more particularly designed for cutting simultaneously the inside and outside of plain rings, with or without key notches, such as are shown on the floor in the illustration. These presses will cut up to about 20 inches outside diameter in this class of work. These rings or discs are then subsequently notched in a notching machine.

The other press, above referred to, is most frequently used for cutting the whole disc, including all the notches, at one blow, and can be used for that class of work up to 11 or 12 inches in diameter. Beyond that size, this press is usually furnished with back gearing and sometimes with a body casting of steel, instead of cast iron. It can, however, be also used for plain rings up to 24 or 30 inches in diameter. It is also a useful machine for cutting the smaller sections for armatures of large generators, in which case the outside of the sections and the holes in same are generally punched simultaneously.

A New Belt Driven Pump.

We illustrate below a double acting, two plunger pump manufactured by the "W. & S." Hydraulic Machinery Works, 204 East 43d Street, New York. This pump is very compactly arranged, as the engraving shows, and the cross heads are provided with ample wearing surface and are well gibbed. The suction valve raises only on the outward stroke

of the piston, the inward stroke driving one-half the water forward and the balance to the front side of the piston, past the pressure valve, whence it is forced forward on the next outward stroke of the piston. The reservoir forms a broad and substantial foundation for the pump and is 40x32x20 inches. The pumps are built in eight sizes, ranging

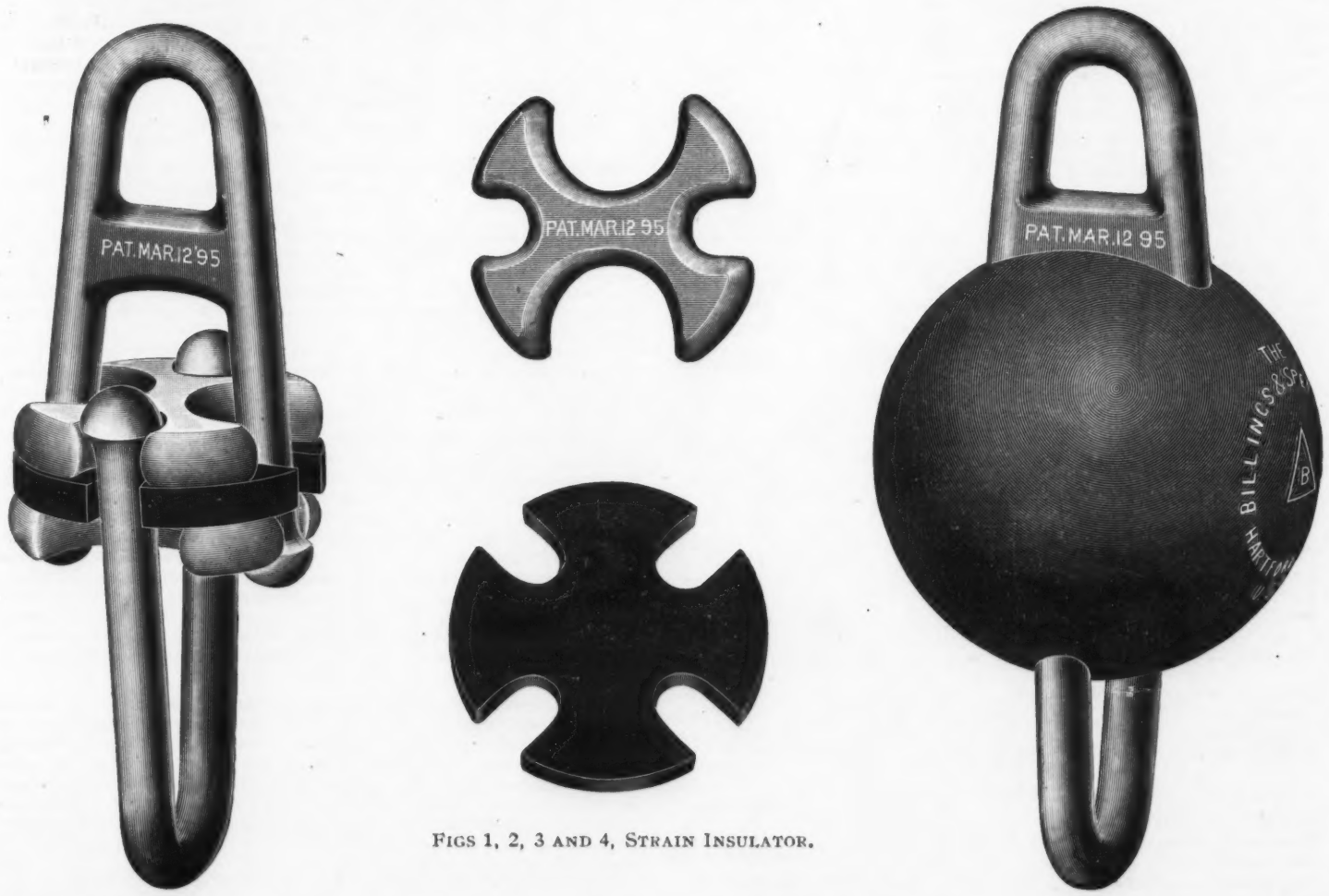


DOUBLE-ACTING PUMP.

from a delivery of 450 cu. in. at 9,000 lbs. pressure per sq. in. up to 4,400 cu. in. at 800 lbs. per sq. in.

Drop Forged Trolley Equipment.

The accompanying illlustrations give a clear idea of the Billings & Spencer Company's new drop forged link strain insulator, which is as desired. Fig. 1 shows the interior construction of the device and Fig. 2 the rubber disc employed to electrically separate the two links. Fig. 3 is the metal holding plate and Fig. 4 represents the complete link strain with the exterior insulating ball. This ball is constructed of a material known as colophite, the invention of Mr. S. J. Hoggson, of New Haven, Conn. The adhesive and elastic properties of colophite make it particularly useful for an insulating compound subject to constant strains and vibrations. It is unaffected by the atmosphere and is a natural preservative impervious to the influences of oxygen, snow, ice and moisture, which are sources of decay in perishable substances. A series of tests have been made of colophite on the Billings & Spencer drop forged link strains, and as a result thereof the company guarantees an insulation resistance of 200,000 megohms at 575 volts. The great advantage claimed for the drop forged parts is that all the pieces subjected to strain or wear are made from material that has a tensile strength of from 65,000 to 80,000 pounds per square inch. The crushing strength of the rubber disc is claimed to be 12,000 pounds. The link strain is furnished with interchangeable attachments which permit of its use as either a frog pull-off or an adjustable pole strain. The same company is also making a straight line trolley hanger with interchangeable parts and an independent colophite insulated stud with ⅝-in. thread, drop-forged of either Tobin bronze or steel. The feature of the straight line hanger is a separate bell made of either aluminium bronze or malleable iron, having interchangeable drop forged yokes of either Tobin bronze or galvanized steel for converting the hanger into either a single or double pull-off.



FIGS 1, 2, 3 AND 4, STRAIN INSULATOR.

being placed on the market by the Pettingell-Andrews Company, of Boston and New York. The metal portions of the link strain are furnished in either Tobin bronze or steel, the latter being nickel plated or galvanized

Progressive Business Methods.

A fine example of wide-awake business policy is afforded by the five-page advertisement of the Bryan-Marsh Company in this issue of THE ELECTRICAL WORLD. There can be no question that the plan thus adopted by the Bryan-Marsh Company in introducing its lamps will create an impression not to be approached by the expenditure of even many thousands of dollars on catalogues, circulars, etc., while the convenience of this method of attracting public attenton stands in striking contrast with the annoying and time consuming labor of preparing and distributing catalogues and circulars. The advertisement also illustrates the growing tendency of large manufacturers to use increased space in order to present their claims in a manner more in accordance with their intrinsic importance. It is fair to assume that, as the art of advertising is more thoroughly studied and understood, the mode of procedure employed by the progressive concern referred to will be more extensively adopted by others.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

THE ELECTRICAL STOCK MARKET continued uneventful during the week, with the exception of General Electric and American Bell, in which there was considerable trading Monday and Tuesday, apparently due to the decision in the Bate Refrigerating case. Notwithstanding official statements that this decision does not appreciably affect the General Electric and American Bell companies, both stocks took a decided downward turn immediately upon the announcement of the decision—the former from 27 to 25⅝ in New York and the latter from 191 to 187½ in Boston. American Bell recovered later, however, and the trading amounted to nearly a thousand shares. The local trading in General Electric on Monday ran over 4,000 shares, the buying coming chiefly from shorts covering. The total sales of General Electric for the week were 33,460 shares. A downward tendency in Western Union and American District Telegraph is again noticeable this week, the latter having dropped from 45 to 41.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Chicago Edison Company	100	128	130
Edison Electric Ill., New York	100	94	96½
" " " Brooklyn	100	..	108
" " " Boston	100	124	125
" " " Philadelphia	100	120	124
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	30	..
General Electric	100	26½	26⅝
General Electric, pref	100	61	65
Westinghouse Consolidated, com.	50	30½	31
" " pref	50	48½	50

BONDS.

Edison Electric Ill., New York	1,000	105	106
Edison Electric Light of Europe	190	75	85
General Electric Co. deb. 5s	1,000	88¾	89

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	190	191
American District Telegraph	100	..	41
American Telegraph & Cable	100	90	92
Central & South American Telegraph	100	117	120
Commercial Cables	100	130	140
Erie Telephone	100	49¾	50
Gold & Stock Telegraph	100	105	110
New England Telephone	100	68	68¼
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	55	58
Western Union Telegraph	100	87	87⅛

ELECTRIC TRACTION STOCKS.

Union Ry. Co. (Huckleberry)	..	112	115
Brooklyn Traction, com	100	9	11
" " pref.	..	53	55
Long Island Traction	100	6¼	7
Rochester St. Ry	..	37	38
Columbus St. Ry	100	46	49
Louisville St. Ry. com.	..	37	39
" " " pref.	..	87	88
Cleveland Electric Ry.	..	59	60
Cleveland City Ry.	..	68	70
North Shore Traction	100	20	24
New Orleans Traction	100	14½	17
" " pref.	100	55	59
Worcester Traction com.	100	..	13
" " pref.	100	79	80
Metropolitan Traction, Philadelphia	..	97⅛	97¼
Philadelphia Traction	..	87⅞	88⅛
People's Traction	..	48⅛	49
Binghamton R. R. common	..	100	..

BONDS

	Bid.	Asked
*Union Ry. 1st. mtge 6s	105	108
*Westchester Electric 1st. mtge. 5s	98	101
Rochester St. Ry. 1st. 5s	95	97
*Columbus St. Ry. 1st 5s	93	..
Columbus Crosstown 1st. 5s	94	..
*Binghamton Railroad Co. 5s	99	100

* With accrued interest.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD.
253 BROADWAY, NEW YORK, March 11, 1895.

THE INTERIOR CONDUIT & INSULATION COMPANY announces that on March 15 its general offices will be removed from 44 Broad Street to 527-531 West 34th Street, New York.

THE PECKHAM MOTOR TRUCK & WHEEL COMPANY has been compelled by largely increasing business to move its Boston office from Room 315 to Room 321, Exchange Building, where more commodious quarters are afforded.

THE MUNICIPAL ELECTRIC LIGHT COMPANY, Brooklyn, has declined to accept the additional franchise granted it by the Common Council two weeks ago, on the ground that the clause in the franchise giving the city the right to take possession of the plant at the end of 10 years at its original cost would interfere with the commercial prosperity of the company.

THE FIRM OF DYER & SEELY, 36 Wall street, has been succeeded by Dyer & Driscoll, Mr. H. W. Seely retiring from business on account of ill health. Mr. R. N. Dyer is widely known throughout electrical circles by reason of his connection with the patent business of the Edison interests, and Mr. Edison personally during the past decade. Mr. D. H. Driscoll has been a member of the old firm of Dyer & Seely for seven years, and has had charge of all matters outside the electrical field.

THE ELECTRIC CONSTRUCTION AND SUPPLY COMPANY of New York has been organized to continue the business of the Electric Construction and Supply Company, which recently failed. The new company is organized under the laws of the State of New York, and it is understood that it will avail itself of such assets of the old company as it may deem desirable, and that some of the employees of the old company are to enlist under its banner. Mr. F. E. Kinsman, who was the original promoter of the first Electric Construction and Supply Company is the prime mover in the reorganization.

ENGLISH NOTES.

LONDON, Feb. 27, 1895.

MUNICIPAL TELEPHONY.—A debate is to take place in the House of Commons on Friday evening next on the subject of the granting of telephone licenses to municipalities.

ACCIDENTS AND EXPLOSIONS.—These continue to occur almost daily. Last week an official of the Bristol Corporation was killed whilst engaged in a job connected with a house transformer, and since then junction box explosions have occurred at Huddersfield and on the network of the St. Pancras Vestry. It is a relief to find that the gas companies are awakening to the proper sense of their duties in the matter of its explosions. At the last meeting of the South Metropolitan Gas Company the chairman, Mr. Geo. Livesay, alluded to the explosion on Southwark Bridge, and said that his company was quite alive to its duties, but the difficulties in the way of the proper supervision of gas pipes were immense.

CHEAP FUEL.—During the past week subscriptions have been invited for shares in a new company styling itself the "Empire" Economical Steam Producer Company. The object of this company is to manufacture a new kind of furnace grate for the consumption of cheap dust fuel, and as much as half of the capital is to be paid to the patentees for their inventions. The promoters of this scheme anticipate being able to get their plant fitted into one per cent. at least of the 300,000 stationary boilers in the United Kingdom, but it seems very doubtful whether dust fuel could be economically used in such a large proportion of boilers. It is rather amusing to note in the patent specifications that it is proposed to force a draft through perforations in the patent grate strong enough to keep the dust fuel floating clear above the grate, but the promoters do not say what is to prevent the fuel floating along the flues and up the chimney.

THE PROPAGATION OF MAGNETISM.—A special meeting of the Institution of Electrical Engineers was held last Thursday, when the members were treated to an interesting discussion by Dr. John Hopkinson, illustrated by some beautiful experiments on "The Propagation of Magnetism in Iron." Dr. Hopkinson's method of procedure is to bore out at different depths in an iron core tunnels in which he places detector coils; the ends being led to separate galvanometers. According to the diameter of the iron core and the strength of the magnetizing forces, the magnetism takes from a fraction of a second to 40 seconds or more to penetrate from the surface into the centre. This phenomenon was made admirably clear to the meeting by means of four galvanometers, the "spots" of which were thrown on to a screen. When the magnetizing current was turned on the top "spot" moved across the scale, and then in slow succession the "spots" underneath it, these belonging to galvanometers connected to exploring coils embedded in the iron at different depths.

General News.

NEW INCORPORATIONS.

THE DALTON TELEPHONE COMPANY, Dalton, Ga., has been organized by Sam. P. Maddox, C. D. McCutchen, Jr., and J. C. Bivings.

THE SPARTANBURG TELEPHONE COMPANY, Spartanburg, S. C., capital stock $10,000, has been incorporated by J. T. Calvert, J. T. Jennings and others.

THE WICHITA MERCHANTS' TELEPHONE COMPANY, Wichita, Kan., has been incorporated by W. A. Minnick, G. W. Clements, J. M. Shakelford and others.

THE FULTON CHAIN TELEPHONE AND TELEGRAPH COMPANY, Boonville, N. Y., capital stock $4,000, has been incorporated by D. B. Sperry, D. Frank Sperry and others.

THE WHITE RIVER WATER POWER COMPANY, Tacoma, Wash., capital stock $2,000,000, has been incorporated to construct an electric power house in the Stuck valley, ten miles east of Tacoma.

THE CUSHMAN UNITED TELEPHONE COMPANY, Chicago, Ill., capital stock $20,000,000, has been incorporated by I. M. Cushman, O. O. Leabhart, and Joseph Barton to build telephone and telegraph appliances.

THE BATAVIA STREET RAILROAD COMPANY, Batavia, N. Y., capital stock $75,000, has been incorporated by Amos H. Stevens, A. B. Wilgus, J. S. Lindsay and others. The road is to be 7½ miles long and extend to Horseshoe Lake.

THE PHŒNIX TELEPHONE & MANUFACTURING COMPANY, Chicago, Ill., capital stock $100,000, has been formed to manufacture and sell telephone and other electrical goods and appliances, etc. LeR. Brown, E. E. Yaxley and J. H. Riley are interested.

THE ONTARIO ELECTRIC COMPANY, Ontario, Cal., capital stock, $100,000, has been organized to generate electricity for heat and power, and to operate water works, etc. John Jenkins, Chicago, Ill.; David Elcoat and Godfrey Stamm, of Ontario, Cal., are interested parties.

THE CITIZENS' ELECTRIC LIGHT & POWER COMPANY, Newark, O., capital stock $30,000, has been formed to generate and supply electricity for light, heat and power. The promoters are Wm. C. Taafel, Wm. D. Fulton, Frank G. Warden, Frank Owens and Wm. E. Miller.

THE CLEVELAND GAS & ELECTRIC FIXTURE COMPANY, Cleveland, O., capital stock $100,000, has been organized to make, buy, and sell gas and electric fixtures, copper and brass goods, etc. The promoters are Burton G. Tremaine, Bernard Schatzinger and Louis Paplous, all of Cleveland.

THE QUEENS COUNTY TELEPHONE, TELEGRAPH AND SUPPLY COMPANY, Oyster Bay, N. Y., capital stock $20,000, has been incorporated by Wm. L. Swan, Geo. W. Faller and others, to build and operate telephone and telegraph lines from Oyster Bay to Huntington, Flushing, Roslyn and intermediate points.

THE CITIZENS' LIGHT, HEAT AND POWER COMPANY, of Mahanoy Township, Shenandoah, Pa., capital stock $10,000, has been formed to supply light, heat and power. The promotors are John Riley and Harvey M. Wood, of 3,330 Woodland avenue, and John T. Lamorell, 506 B. 18th street, Philadelphia, Pa.

THE ANSONIA ELECTRICAL COMPANY, Ansonia, Conn., capital stock $56,000, has been formed to manufacture, buy, sell, etc., any and all kinds of articles, machines and supplies used in whole or in part for electrical purposes, etc. The promoters are Franklin Farrell, Franklin B. Platt, and Thos. Wallace, Jr., Ansonia, Conn.

THE AMERICAN COAL COMPANY, Seattle, Wash., capital stock $300,000, has been formed to mine, deal in minerals and fuel; operate steamboats, vessels, heater works, railways, telegraphs and telephones, and electric plants. The organizers are Frederick Nolte, P. O. Skoyan, Alfred Meyers, W. A. Burleigh, Jr., and Geo. E. Wright.

THE MILAN, BIRMINGHAM & ELYRIA ELECTRIC RAILWAY COMPANY, Birmingham, O., capital stock $100,000, has been formed to construct and operate an electric railway and to furnish light, heat and power, etc. The organizers are Geo. W. Clary, C. P. Baker, H. P. Starr, H. D. Olds, W. L. Fay, F. Burk, E. H. Andress and C. A. Bristol.

THE FRANKLIN ELECTRIC ILLUMINATING COMPANY, Oyster Bay, N. Y., capital stock $25,000, has been incorporated for the purpose of supplying electricity for producing light, heat or power in the villages of Sea Cliff, Glen Cove, Red Spring, North Country and Dosoris. The promoters are Samuel Stenson, John Graham, Wm. A. Porter and others.

THE ALLENTOWN & READING ELECTRIC STREET RAILWAY COMPANY, Philadelphia, Pa., capital stock $108,000, has been formed to build an electric railway. Victor D. Barnes, Allentown; W. H. Kennedy, and P. J. Moore, Philadelphia, Pa., are interested. The company may be addressed in care of W. P. Rambo, 608 Penn Mutual Building, Philadelphia, Pa.

TELEGRAPH AND TELEPHONE.

READING, PA.—Steps are being taken to build a telephone factory in Reading.

BOYD'S, MD.—The Boyd's Telephone Company is in the market for electrical supplies.

HAZLETON, PA.—A long distance telephone line is to be built from here to Beaver Meadow.

HOLLAND, MICH.—W. A. Watson, of Grand Rapids, will establish a telephone exchange by April 1.

PALMYRA, MO.—Benjamin Moss and others have organized a company to establish a telephone system.

CHAMPAIGN, ILL.—Dr. P. S. Replogle has received a franchise to construct a telephone system in Champaign.

ATCHISON, KAN.—A new telephone company has been organized but will not begin operations until 300 names are secured.

CARTHAGE, MO.—Marion Caldwell, of the Phœnix Telephone Company, has been granted a franchise to establish a telephone system.

NYACK, N. Y.—M. F. Colgrove and others are organizing a company in Rockland County to connect the principal telephone lines of that county.

READING, PA.—Reading's Councils have granted the Pennsylvania Telephone Company permission to operate underground conduits in the city.

PITTSBURGH, KAN.—The Phœnix National Telephone Company, of Indianapolis, has secured a franchise in Pittsburgh, Kan., and will construct a telephone system.

CANTON, O.—The Canton Telephone Company's franchise has been amended so as to permit the stringing of wires in cables on poles instead of in underground conduits.

SHARON, PA.—The Harrison Telephone Company has been granted a franchise to construct their lines through Sharon, and will operate in opposition to the Bell Telephone Company.

DUNKIRK, IND., will soon have its telephone system completed. The city has contracted with the Indiana Telephone & Construction Company, of Frankfort, Indiana, to use the Strowger Automatic Telephone Exchange.

CHAMPAIGN, ILL.—A company of capitalists is completing arrangements to put in a telephone exchange in Champaign and Urbana to compete with the Central Union. Connecting lines will be established with Danville, Decatur and Bloomington.

ELECTRIC LIGHT AND POWER.

MONTEZUMA, IND., is considering the question of putting in an electric light plant.

JAY, GA.—A fine mill is being erected by Messrs. Lance, Wood and others, to be run by electricity.

CAIRO, ILL.—A receiver has been appointed for the Delta Electric Light & Power Company.

NEW CASTLE, PA.—A complete system of electrical cranes will be put in the New Castle Steel & Tinplate Mill.

NEW LISBON, WIS.—The leading business and professional men of this city are advocating an electric light plant.

CENTRALIA, WASH.—The city has voted to issue 20-year bonds for the purpose of erecting an electric light plant.

MIDDLETOWN, N. Y.—The Middletown Light & Power Company is said to be in financial difficulty, a receiver having been appointed.

NEBRASKA CITY, NEB.—Plans and specifications for an electric lighting plant to cost $18,200 were accepted by the Council and placed on file.

CHESTER, PA.—The Chester Electric Light & Power Company are negotiating for a site for the erection of an electric light and power plant.

HOLLAND, MICH.—The Council committee on ways and means has recommended the issue of bonds for $12,000 to be used in extending the city's electric light plant.

MT. MORRIS, N. Y.—The Mt. Morris Electric Light Company has contracted with the city to furnish 1,200-cp arc lights every night until 1 a. m. for $57 per lamp per year.

NYACK, N. Y.—Abraham E. Benson, of New York City, will erect at the corner of Church street and Broadway, Nyack, a five-story building, to be electrically lighted by an isolated plant.

NORWALK, O.—The Norwalk electric light plant, which has been in the hands of assignees for some time, has been sold to B. P. Foster, of Toledo, for $13,000. The plant originally cost $50,000.

OAKLAND, CAL.—The Oakland Gas Light & Heat Company will enlarge its plant so as to be able to supply power, and the company is now in the market for $100,000 worth of new machinery.

CANAJOHARIE, N. Y.—The Canajoharie Electric Light & Power Company has made a contract with the village to furnish 30 arc lights of 2,000 cp each for $2,000 per year. The company has agreed to have the plant completed by June 1, but it will probably be finished by May 1.

CLEVELAND, O.—Sealed proposals will be received until March 16 for furnishing electric motors and machinery for operating the Columbus street double-swing bridge. Plans and specifications may be seen, and blank proposals can be obtained at the office of the chief engineer after March 11. J. H. Farley, director of public works.

MILWAUKEE, WIS.—Sealed proposals will be received until March 12, 1895, for furnishing all materials and doing all work necessary to complete and install an electric light and power plant in the new City Hall, according to general specifications (and plan attached thereto) on file in this office. For further information address Wm. J. Fiebrantz, comptroller.

THE ELECTRIC RAILWAY.

ALTOONA, PA.—The City Passenger Railway Company will extend its lines to Newburg.

ST. LOUIS, MO.—The Jefferson Avenue Railway Company will change its motive power to electricity.

KINGSTON, N. Y.—The Colonial Street Railway Company is reported as being in the hands of a receiver.

PEORIA, ILL.—The Central Street Railway management will extend its line this spring to Springdale Cemetery.

ANNAPOLIS, MD.—Arrangements are being made to begin the construction of the Annapolis and Bay Ridge electric line.

NIAGARA FALLS, N. Y.—W. Carly Ely has been granted a franchise to construct a trolley line through North Tonawanda.

NORTH ATTLEBORO, MASS.—A syndicate headed by Mr. E. R. Price have been granted a franchise for an electric railway.

DENISON, TEX.—The street car properties here have changed hands, and will be electrically equipped. Geo. L. McLagan may be addressed.

POTTSVILLE, PA.—When the weather grows warmer the Schuylkill Electric Railway Company will commence $200,000 worth of trolley construction in Pottsville and suburbs.

PROVIDENCE, R. I.—The Narragansett Electric Lighting Company has received permission to maintain poles and wires along Arlington avenue from Humboldt avenue to Lloyd avenue.

VALPARAISO, IND.—A stock company has been formed composed of Chicago, Valparaiso and Hobart capitalists, to build an electric road from this point to Chicago. Freight to be shipped also.

AUGUSTA, ME.—In the House the bill to extend the charter of the Washington County Railway Company was amended to allow the construction of branch lines to be operated by either steam or electricity.

ALLENTOWN, PA.—A charter was granted by the State Department at Harrisburg to the Allentown & Reading Electric Railway Company, capital $108,000. Dr. J. S. Trexler, of Kutztown, is president of the company.

EDGEWATER (P. O. CHICAGO), ILL.—The electric power house of the Chicago & North Shore Electric Railway at Edgewater has burned down. The dynamos and most of the motor cars were destroyed. Loss $150,000.

CARLETON PLACE, ONT.—A charter has been granted for an electric railway 12 miles long between Napierville and Remi, Quebec, and another charter has been asked for a road between Lanark and Perth. The organizers will be ready about March 20 to make contracts for building both lines. James Fowler, Carleton Place, is interested.

GENEVA, N. Y.—Thomas Craig and others have purchased the Geneva & Waterloo electric railway, and will operate it in connection with the Seneca Falls & Waterloo Railway and with the Cayuga Park road, making a continuous line between Geneva, Cayuga and Cayuga Lake. It will be known as the Geneva & Cayuga Lake Traction Company.

PORTLAND, ME.—President W. R. Wood, Supt. E. A. Newman and others have returned from a trip to New York, Boston and other places, where they have been inspecting and contracting for electrical appliances for changing the car lines of the Portland Railway Company. Work will probably begin here April 1 and be completed by July 1. The three engines of the present Deering plant will be removed into the new station house, and in addition will be put in two large compound condensing engines, capable of developing 800 horse power each. When the whole system is equipped the company will have 21 miles of electric road.

Personal Notes.

MR. W. FRANK CARR, formerly general manager of the Roanoke Electric Light & Power Company, Roanoke, Va., has been appointed superintendent of electrical construction for the West Chicago Street Railway Company, vice Mr. J. S. Hill, resigned.

WHEN CHARLES E. BILLINGS organized the Billings & Spencer Co., of Hartford, Conn., in 1869, after having been connected with the Colt's Patent Fire Arms Company for six years, and afterwards with the gun factories of E. Remington & Sons, the process and methods of drop forging were crude, the work imperfect and the limits of practical application narrow. For a long time the latent possibilities in the system waited for the right man to develop them. It remained for the inventive talent of Mr. Billings, organizer and president of this company, to perfect the art of mechanical forging, which has been done on scientific principles. A single instance will illustrate: While visiting the Edison Machine Works in New York City in 1886, he noticed the method employed in making commutator bars. The segments were made in two pieces, united by rivets and solder. In conversation with the general manager of the works, the latter expressed the opinion that it was not possible to produce a commutator bar of one piece of wrought copper and give it the required shape. Mr. Billings, upon his return to Hartford, made a series of experiments, and in two months sent to the Edison Company an invoice of drop forged, pure lake copper commutator bars, each one made of a single piece of wrought copper, having a homogeneous molecular structure throughout, of the greatest possible density with an increased efficiency.

Miscellaneous Notes.

THE AMERICAN TELEGRAPH UNION was organized last week by a number of telegraph operators at a meeting in Clarendon Hall. About two hundred men were present. The meeting was called to order by Robert L. De Akers, who made an address advocating government control of the telegraph lines of the country. Mr. De Akers said the object of the organization was not for the purpose of precipitating or aiding strikes, but purely to expedite government control. Charles Matchett, a speaker on economic problems, also made a long address on government control. It was reported that similar organizations were being formed in Boston, Philadelphia, Chicago and other cities.

A COURSE OF SIX LECTURES on how electricity is now being utilized will be given by Prof. F. B. Crocker, in Room 11, Library Building, Columbia College, New York, on successive Thursday evenings at 8.15 o'clock, beginning March 21. These lectures will be very fully illustrated by experiments, and are specially intended for professional and business men who desire to obtain an intelligent idea of the present uses of electricity. Some of the subjects to be covered are "How Electricity Is Generated and Stored," "Alternating Currents," "Electric Railways," and "How Electricity Is Used for Lighting and Heating." Tickets for the course, at $5, may be obtained of the secretary or the president, Columbia College. Tickets will not be sold for single lectures.

A COURSE OF LECTURES ON ELECTRO-CHEMISTRY.—There has been started at the Johns Hopkins University an addition to the present electrical course, consisting of lectures and laboratory work on electro-chemistry. The work is being done by Mr. H. C. Jones, Ph.D., who has had a thorough training in this country and abroad under Ostwald. The course consists briefly of: 1. A historical sketch of electro-chemistry, including theories on electrolysis. 2. Electrical energy. 3. Discussion of the laws of Faraday. 4. The wandering of ions. 5. Conductivity methods and results. 6. Properties of ions. 7. Electromotive force. 8. Polarization. 9. Electrolysis. 10. Electro-chemical analysis. 11. Electro-metallurgy. There will be laboratory work in electrolysis and electro-metallurgy, and in such experiments as conductivity methods, etc. This course will be elective this year. It is attended by 50 students, of whom 27 are electrical engineers, 9 physicists, and 14 chemists.

Trade and Industrial Notes.

RALPH L. MONTAGUE, 1,504 Washington avenue, St. Louis, Mo., is publishing a handy wiring computer gotten up in chart form, which he is selling at a very reasonable price.

THE AMERICAN CIRCULAR LOOM COMPANY, Boston, Mass., is distributing a folder containing a number of strong testimonials concerning its flexible conduit, and a long list of users of the same.

MESSRS. WERNER & PFLEIDERER, Cannstatt, Wurtemburg, Germany, manufacturers of mixing and kneading machinery, include in their line mixing machines for use in the manufacture of arc light carbons.

MESSRS. DEEN & SCHAUM, Lancaster, Pa., announce that business in Lancaster is very good at present, and that the consolidation of the various electric light plants of that city has increased the motor business considerably.

MESSRS. H. B. COHO & CO., 203 Broadway, New York, announce among their recent contracts the electrical equipment for the Portland Apartments, Washington, D. C., and the new Lauderdale Building, Providence, R. I., and several motors for Messrs. Deen & Schaum, Lancaster, Pa.

H. E. COLLINS & CO., Pittsburgh, Pa., have just issued a very neat illustrated pamphlet describing the Cahall vertical water tube boiler, for which they are sole United States agents. Very strong claims are made for the boiler, and a report is presented of a test made at Pittsburgh, which gives a very good showing.

STONE & WEBSTER, 4 Post Office Square, Boston, are distributing a pamphlet entitled "A Modern Power Plant," descriptive of a power station erected at Allentown, Pa., by the Industrial Improvement Company, of Boston. The plant is an interesting one and the designation embodied in the title of the book is very appropriate.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has secured the contract for the new station building of the Poughkeepsie (N. Y.) Electric Light & Power Company. The dynamo room will be 61x172 feet and the boiler room 60x77 feet, the whole to be covered with the Berlin Company's patent anti-condensation, corrugated iron roofing. This company also has a contract for an iron roof for the Hudson River Water Power & Paper Company's new machine shops.

THE ELECTRIC APPLIANCE COMPANY, Chicago, is rejoicing over the decision in the Bate Refrigerating case. It is of particular value to the company in that it is enabled to be in the market again with the old reliable Packard lamp with platinum leading-in wires, which it has heretofore been unable to supply, owing to patent litigation. Where the merits of the old lamp are known the Electric Appliance Company states that a simple mention of the above facts brings in the business in a way that is making them decidedly happy.

THE NEW YORK ELECTRIC COMPANY, of Youngstown, O., is anxious to ascertain the whereabouts of A. F. Opperman, its former traveling salesman. It is reported that Opperman collected outstanding bills for the company, but entertained the opinion that he could use the money to better advantage than his employers, and accordingly decamped with something like $1,300. The shortage will not interfere with the company's operations, but its officials are desirous of finding Opperman and reconciling the difference of opinion as to the proper disposition of that money.

NORMAN HUBBARD, of 93 Pearl street, Brooklyn, manufacturer of the Packard vacuum pump, so largely used in the manufacture of incandescent lamps, reports a large increase in the number of inquiries received since the decision in the Bate case, indicating that there will probably be a number of new factories started. There are over 200 Packard pumps now in use by lamp makers in this country and Europe. These pumps are not intended for the final exhaustion of the lamp globes, but are used in connection with the carbon flashing apparatus and for operating mercurial pumps.

THE BILLINGS & SPENCER COMPANY, of Hartford, Conn., is now preparing to manufacture, in connection with its regular business of machinists' tools and drop forgings a line of drop forged overhead trolley equipment. The experience and reputation of the company during the past 26 years is sufficient guarantee that the drop-forged trolley material they are now introducing will supply a long-felt want, and will be generally accepted by the electric railways. The Billings patent drop-forged commutator bars are now in general use by street railways, and are very extensively used by some of the largest electrical manufacturing companies in the United States.

THE GOULDS MANUFACTURING COMPANY, of Seneca Falls, N. Y., was the successful bidder for triplex power pumps, boilers and engine for the new water works at Canandaigua, N. Y. This is to be an electrically operated pumping station, the plant consisting of a power station in Canandaigua and a pump-

ing station at 33⅓ miles distant on the shore of Lake Canandaigua. The triplex pumps to be used for this plant will have 12x12-in. cylinders and be capable of delivering 1,000,000 gallons per day each The pumps are to be driven by electric motors, current being supplied from the local power station. This plant will be the largest electrically operated water works in the United States.

AN EXCELLENT LITTLE DEVICE in the shape of a "date label" is being used by the New York & Ohio Company, Warren, O., makers of Packard lamps. A small label is pasted on each lamp, on which is printed besides the candle power and voltage in the usual manner, three spaces headed respectively, Fin.——, Up——, B.O.——. In the first is marked at the factory the date on which the lamp is finished. The other two spaces are for the use of the consumer, to mark the date the lamp is put up and the date burned out. By this means users can be assured of getting "fresh" lamps, and can readily keep a record of their life. The device is certainly an evidence of good faith on the part of the maker and is a great convenience to the user.

MR. R. B. COREY will carry on an arc lamp and carbon business at 714 Havemeyer Building, New York City, with the Wallace Electric Company, Chicago, as western representatives John C. Knight, under whose arc lamp patents the Electric Construction and Supply Company manufactured this line of lamps, will be associated with Mr. Corey. The business will include the manufacture and sale of direct current lamps of all lengths and both plain and ornamental, twin lamps for direct current, alternating lamps, plain and ornamental, and street railway lamps; series arc lamps, plain and ornamental, and all styles of focussing lamps for photo-engraving, theatrical and photographing work, search lamps; in fact, everything that is practicable in the arc lamp line.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., reports the following recent sales made through its well-known western contractor, Mr. J. Holt Gates, of Chicago: two 65-kw new type direct-connected generators for Fort Dearborn Building, Chicago, to be used in connection with Ball & Wood engines; two 50-kw direct connected generators to be used with McIntosh & Seymour engines for the Lauderdale Building, Providence, R. I.; one 85-kw 220-volt generator to the Walter Ferris Coal Company, Salem, Ohio, and two 30-kw new type multipolar generators for the station of the Catasauqua Electric Light and Power Company, Catasauqua, Pa. The two generators last mentioned are of the Mather Company's latest type, and their speed does not exceed 300 revolutions per minute.

THE HEINE SAFETY BOILER COMPANY, of St. Louis, has closed a contract for 1,332 hp for the new high duty dredge boat which the government has just contracted for. The boat is for Ohio and Mississippi river service, and is of about 1,000 tons burthen. It will be equipped with the highest grade of machinery, and is expected to make quick work with sand bars. The Heine Company feels particularly complimented by the selection of its boilers. The points of advantage in the Heine boiler which influenced its selection were its compactness, giving maximum power in minimum space; its economical use of fuel, involving smaller stocks of coal, and its ability to work with *extremely muddy water* just as it comes from the river. The special Heine mud drum permits deposit and removal of a large percentage of sediment in the water before it gets to the boiler proper.

Business Notices.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MARCH 5, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

535,010. TRANSFORMER; Fred S. Hunting, Fort Wayne, Ind. App. filed Feb. 25, 1892. A transformer comprising two or more circuits for inducing currents differing in phase, and cores influenced thereby so as to differ in inductive power, and a secondary circuit or circuits comprising in each a coil or coils wound on two or more of the cores in multiple.

535,027. RHEOSTAT; A. J. Shaw, Muskegon, Mich. App. filed Dec. 1, 1894. In a rheostat or like structure, the combination of a fixed conducting body adapted to be included in circuit, and provided with a rotatable contact and a pivoted or yielding contact finger movable against or over said rotatable contact.

535,042. TELEPHONE APPARATUS; O. L. Wullweber, Chicago, Ill. App. filed Jan. 7, 1893. The combination of a fixed frame having an arm for supporting the transmitter mouthpiece, of a ring fixed upon said arm for holding the mouthpiece, side projections on said ring and a folding extensible holder pivotally secured to such projections.

535,051. ELECTRIC ARC LAMP; H. P. Davis, Pittsburgh, Penn. App. filed Oct. 23, 1893. In an arc lamp a feed train for the movable carbon comprising a smooth brake wheel in combination with a pivoted brake lever having a notch, the sides of which are adapted to clip said brake wheel and a series and shunt coil adapted to cause said notch to hold and release said brake wheel.

535,052. ELECTRIC ARC LAMP; H. P. Davis, Pittsburgh, Pa. App. filed May 3, 1894. In a feed mechanism for arc lamps, a movable gear train for tripping the arc, an escapement for controlling the action thereof, a pivoted weighted stop located in the path of movement of said escapement and adapted to yield whenever the escapement is moved into engagement therewith and operating directly and solely by its weight to lock said escapement against movement.

535,060. DEMAGNETIZING APPARATUS; C. Houlgrave, Buffalo, N. Y. App. filed Jan. 22, 1894. An electromagnet comprising a solenoid having paramagnetic portions arranged externally, said paramagnetic portions consisting of two poles arranged diametrically opposite each other, and formed of laminals set on edge and arranged longitudinally of the solenoid windings, whereby an intense magnetic field may be formed within the solenoid.

535,067. ADVERTISING DEVICE; J. Montagner, Buenos Ayres, Argentine Republic. App. filed Dec. 15, 1894. A clutch comprising the combination of a plate secured to one shaft having two or more sets of apertures arranged in concentric circles, the apertures in the several circles being displaced angularly with reference to each other and a lever secured to the shaft carrying a plurality of pins, one of which will fit into one of the apertures.

535,069. LIGHT FIXTURE OR ANALOGOUS ARTICLE; W. McElroy and G. W. Bayley, Brooklyn, N. Y. App. filed May 9, 1891. An insulated coupling for light fixtures, comprising two tubular metallic sections insulated at their juncture by a washer of insulating material, the uppermost of said sections carrying an annular depending lip arranged out of electrical contact with the lowermost section and constructed of less outer diameter than the adjacent interior of the lowermost of said sections, whereby the drip through the coupling is precipitated within said lowermost section near its centre.

35,072. COOKING AND HEATING APPARATUS; H. G. O'Neill, Boston, Mass. App. filed Feb. 8, 1894. An article or utensil provided with an insulator and rigid conductors attached to the ends of the said insulator, and in combination with a range table or other support having depressible contact pieces arranged to receive the pressure of the said conductors or feet when the latter are set on them, circuit wires or equivalent conductors running to the said contact pieces and an electric lamp and connections arranged to be brought into the circuit when the said springs are thus depressed.

535,077. CIRCUIT INTERRUPTER FOR ALTERNATING ELECTRIC CURRENTS; H. N. Potter, Alleghany, Pa. App. filed Feb. 28, 1894. A circuit interrupting device, a number of non-arcing metal cylinders having gaps between them adapted to be bridged for the completion of a circuit, in combination with a shunt around one or more of said gaps, and device in said shunt for counteracting the arcing of lag in the current to be interrupted.

535,084. INSULATING CONDUIT FOR ELECTRIC CONDUCTORS; L. B. Stillwell and C. F. Scott, Pittsburgh, Pa. App. filed Oct. 25, 1894. A conduit for electric conductors comprising a plurality of tubes of insulating material, each consisting of telescoping joint-breaking sections, and all inclosed in a pipe or tube, the entire space in and around the said insulating tubes, except that occupied by the conductors, being filled with non-conducting liquid.

535,086. LIGHTNING ARRESTER; A. Wurts, Pittsburgh, Pa. App. filed Feb. 28, 1894. The combination with a plurality of non-arcing metal parts of a two part insulating holder therefor having oppositely arranged aligned sockets in which said non-arcing metal parts are seated, and passages leading outward from between said sockets.

535,090. ELECTRIC BATTERY; H. J. Brewer, New York, N. Y. App. filed May 2, 1892. The combination with a battery element, of a cover for the battery cell, a block or part of insulating material supported by the cover, a shank extending from said element into this block or part, a conductor fitting within said block or part in electrical communication with said element, and a set screw passing through said block or part and clamping the said strip of metal.

535,100. BURGLAR ALARM FOR GLASS DOORS; J. B. Gill, San Francisco, Cal. App. filed Feb. 27, 1893. In a burglar alarm a thin strip or film of metal applied to the inner face of glass doors, windows, etc., the continuity of which is broken and the ends provided with conductive metal inclosed by bibulous paper, connecting with the wires of a battery.

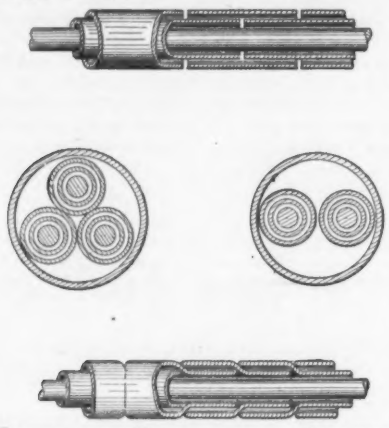
535,104. ARMATURE WINDING MACHINE; H. E. Heath, Windsor, Conn. App. filed May 15, 1894. In a winding or taping machine of this class an annular spool-carrier supported for rotation between peripherally disposed wheels or rollers and consisting of two rings having their inner faces mortised to form an elongated bearing for the axles of the tape-carrying spools, in combination with tape-carrying spools revolubly and removably supported in said bearings, spool-retaining tension devices, in connection with and adapted for preventing displacement of said spools and for regulating the tension of the tape as it is unwound from said spools, and means for rotating the carrier.

535,105. APPARATUS FOR WINDING ARMATURE COILS; H. E. Heath, Windsor, Conn. App. filed May 15, 1895. The combination consisting of a revoluble carrier having a retaining flange at one end thereof, a series of duplicate interchangeable former sections each comprising an annularly recessed hub with a transversely grooved peripheral flange at one end thereof, a combined guiding and locking device connected with said carrier and adapted for facilitating the positioning of the several sections relatively to each other and for locking them against rotation with each with relation to said carrier, and a binding-nut screwed upon the unflanged end of said carrier and clamping the several sections between said nut and the carrier-flange.

355,106. METHOD OF FORMING ARMATURE COILS; H. E. Heath, Windsor, Conn. App. filed May 15, 1894. The method of forming armature coils for dynamo-electric machines, which consists in first winding upon a former an elongated hexagonal coil having its opposite sides parallel with each other; and second, bending all of the short sides of said hexagon inwardly, without increasing the number of salient angles therein, and while maintaining the long sides in parallelism, to form two similar but oppositely disposed end portions, each of which has two parallel members perpendicular to the aforesaid long sides, and to form also a third short member connecting and

perpendicular to each pair of said parallel members and in alignment with the opposite short member.

535,107. WINDING OR TAPING MACHINE; H. E. Heath, Windsor, Conn. App. filed May 17, 1894. The combination with an annular spool carrier, of a stud, a tape carrying spool mounted upon said stud and adapted for rotation in a plane at an inclination to the plane of rotation for said carrier, and a clamp-screw adapted for pivotally securing said stud to one side of the carrier and for locking said stud in its adjusted position to prevent pivotal movement of said stud.



No. 535,084.—Insulating Conduit for Electric Conductors.

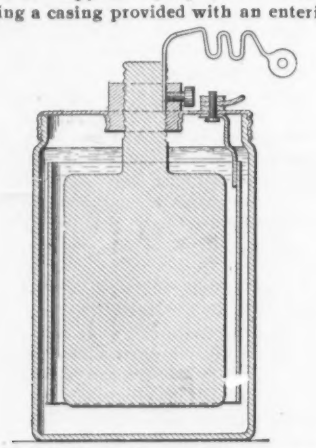
535,149. SWITCH; C. S. Van Nuis, New Brunswick, N. J. App. filed Sept. 17, 1890. The combination of a switch arm, circuit terminals, contact plates secured to said circuit terminals and with which said switch arm makes contact, carbon contact plates also secured to said circuit terminals, and contact springs carried by said switch arm for making contact with said carbon contact plates.

535,158. METHOD OF AND APPARATUS FOR REGULATING ELECTRIC CIRCUITS; J. M. Bradford, Portland, Me. App. filed Jan. 9, 1894. The combination of a normally stationary current-varying device, electromagnets to govern the movements of said current-varying device, a stop-motion device to aid in controlling the movements of said current-varying device, electric circuits and a main current controller to cause said electromagnets and stop motion device to act oppositely by turns and driving gear to move said current-varying device progressively or retrogressively.

535,179. TYPEWRITING MACHINE ATTACHMENT; C. Spiro, New York, N. Y. App. filed Oct. 9, 1894. The combination with the type-bar, ligament and key-lever of a typewriting machine, of a fixed conductive bar, a pivoted contact arm carried by a pivoted device, a link connecting said arm with the key lever, a retarding mechanism, and a link connecting the same with said key lever whereby the contact arm is thrown out of operation in the downward or printing movement of the key-lever, and is brought into operation with retarded speed upon the return movement of the key-lever.

535,199. INCANDESCENT LAMP; F. L. Fowler, Philadelphia, Pa. App. filed July 30, 1894. The combination of a bulb having a projecting flange, the collar having a seat for said flange and having also external screw threads of different diameters, the filament carrying a plug screwed into the said collar, and a packing ring interposed between the said plug and the flange of the bulb.

535,214. CONTACT DEVICE FOR CONDUIT ELECTRIC RAILWAYS; F. R. Lodetti, Rondout, N. Y. App. filed May 4, 1894. The combination with a feed conductor having a casing provided with an entering slot, of a vehicle



No. 535,090.—Electric Battery.

having an elastic guide arranged longitudinally, said guide being adapted to enter and move in the said slot, and a collector depending from the guide throughout its length and attached thereto at intervals and having electrical connections with a motor on the vehicle.

535,247. BATTERY TELEPHONE TRANSMITTER.; W. W. Jacques, Newton, Mass. App. filed June 22, 1894. A telephone transmitter with an electrode or variable resistance medium consisting of metal with its surface converted into one of its own salts.

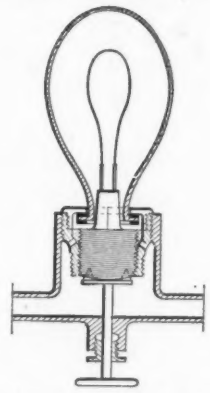
535,284. TELEPHONE TRANSMITTER; J. H. M. Goodman, Louisville, Ky. App. filed Sept. 19, 1894. A telephonic instrument with the diaphragm and with two magnets having their opposite poles approximated and a mass of comminuted magnetic material interposed between such poles, of a spring or flexible arm forming a support for one of said magnets, and maintaining it in light contact with the diaphragm, and an adjustable arm forming the support for the other magnets.

535,289. TELEPHONY; W. W. Jacques, Newton, Mass. App. filed May 26, 1892. A method for transmitting vocal or other sounds electrically, which consists in passing through a multitude of loose contacts in a circuit an electrical current sufficiently strong to maintain said contacts in continuous rapid vibration and superimposing upon such vibrations due to sound waves.

535,294. CLOSED CONDUIT FOR ELECTRIC RAILWAYS; P. Murphy, Chicago, Ill. App. filed Jan. 9, 1894. The combination with a trolley wire of a normally closed circuit inclosing same said conduit, comprising a pair of hinged members with their edges normally closed together and traveling wheels supported on the car, and adapted to move on the exterior of said conduit, for engaging said hinged members to separate the same and permit the passage of the trolley support.

535,297. SECTIONAL CONDUCTOR SYSTEM FOR ELECTRIC RAILWAYS; A. Rosenholz, San Francisco, Cal. App. filed Oct. 11, 1894. An electric conduit and distributing switch, consisting of a hermetically inclosed and insulated main conductor having contact points exposed at intervals, sealed insulating casings with insulating journals turnable about the main conductor and inclosing the exposed portions thereof, said casings supporting independent sectional trolley wires upon the movable ends, and interior contact plates and armatures connected with the trolley wires, stationary cores fixed to and insulated from the main conductors projecting within the insulating casings and having contact plates adjacent to those carried by the casings, and insulated conducting wires coiled about the core, connected with the main conductor at one end, and with the contact end of the core at the opposite end.

535,299. COMBINED TELEGRAPH AND TELEPHONE SYSTEM; C. A. Shea, Boston, Mass. App. filed Jan. 3, 1893. In a combined telegraph and telephone system, the combination of two main lines, independent telegraph instruments therefor, a telephone or telephone converter, two branches proceeding from each telegraph instrument and oppositely wound about the telephone or converter coils, one of said branches at each side being connected with its main line, means for stopping telephonic impulses along the other branches and a telephonic circuit connection between the lines.



No. 535,199.—Incandescent Electric Lamp.

535,304. MOUNTING FOR ELECTRIC MOTORS; E. A. Sperry, Cleveland, O. App. filed April 13, 1894. In a power transmission for vehicles a bi-axle running gear, a motor mounted upon each axle through an elastic connection and extending therefrom in such a manner that its centre of gravity shall pass through a vertical at one side of the axle, an arm extending from one motor to the other attached to the motors at points on the opposite sides respectively of their centres of gravity.

535,321. ELECTRIC HEATER OR RHEOSTAT; J. H. Delany, New York, N. Y. App. filed Nov. 23, 1894. An electric heater or rheostat consisting of a base or support of porcelain or such like material, a heating or resistance conductor applied thereto, and a coating of vitreous enamel intimately united with the base and conductor, and securely uniting them, and an exposed contact plate or terminal embedded in and secured in position by the enamel coating.

535,324. ELECTRIC RAILWAY CONDUIT; W. T. Dulany, Jr., New York, N. Y. App. filed Dec. 14, 1894. In an electric railway conduit having a drainage cesspool connected therewith, the combination of the cesspool discharge pipe having a float check valve therein, an electrically operated pump having its suction pipe within said drainage cesspool and means whereby said pump is automatically started and stopped by variations in the level of the water in said drainage cesspool above the float check valve.

535,332. TRAIN SIGNAL FOR RAILWAYS; A. H. R. Guiley, S. Easton, Pa. App. filed Jan. 22, 1894. The combination of long thin plates bent downward and fastened at their ends, a series of standards secured to the tiles and plates, and a series of contact buttons inserted at intervals along the plate composed of plugs or bolts of non-oxidizing metal or of a metal which is protected by galvanic union with the iron of the plate and connected to the wire of the plate.

535,336. ELECTRIC LAMP SUPPORT AND CUTOUT; L. Johnson, New Albany, Ind. App. filed April 5, 1894. The combination of a supporting wire, hangers attached thereto, loops carried by the lamp, a carrier movable back and forth along the wire relative to said hangers, two sheaves journaled by the carrier, a rope passing from the lamp to each of said sheaves, thence in opposite directions to suitably located pulleys, and thence to a point at which it may be manipulated to move the carrier in either of its directions along the wire.